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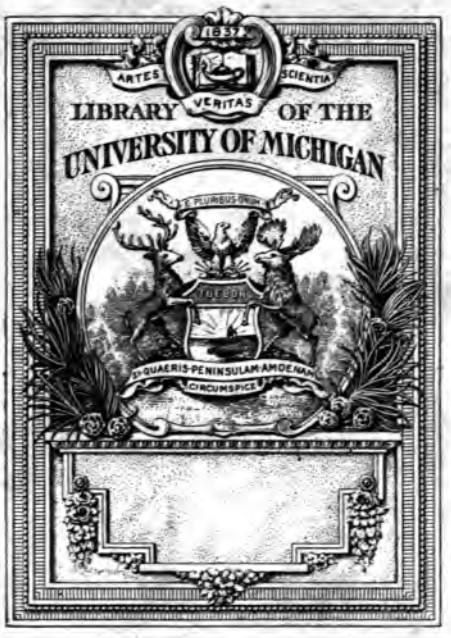
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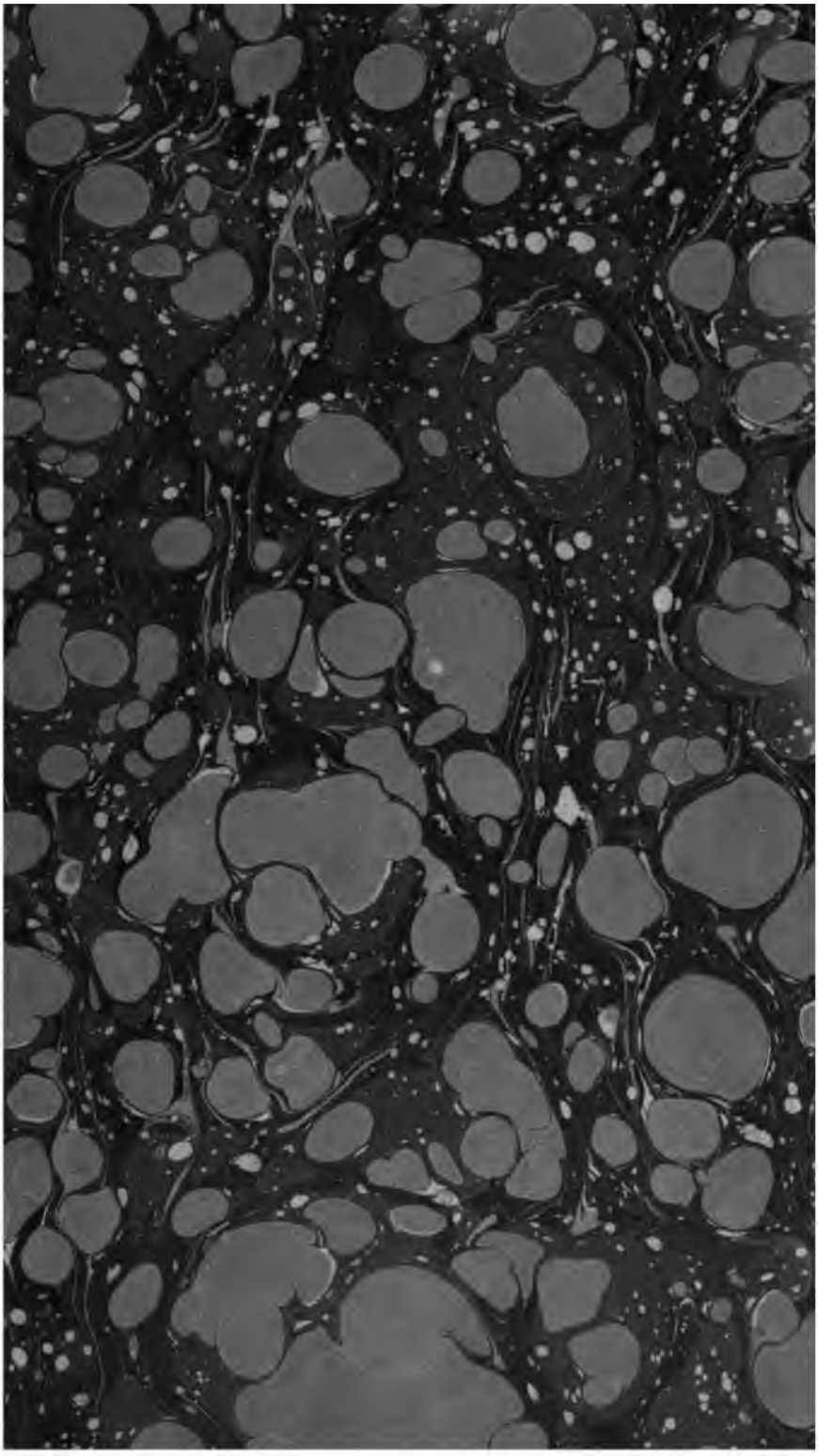

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MEMOIRS

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SECOND SERIES

VOLUME I.

PRINTED FOR
R. BICKERSTAFF, STRAND, LONDON,
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1805.

ADVERTISEMENT.

MORE than twenty years have elapsed since the publication of the first volume of the Society's Memoirs. In this period five successive volumes have appeared, the two last of which were published in separate parts. The first and second have been reprinted, and a few of the copies are still on sale; the third is out of print; and some of the fourth and fifth remain in the publisher's hands.—The progress of the experimental Sciences has been so considerable of late years, as to render ineligible the republication of Essays however valuable originally. The inability, also, of procuring a complete set of the Memoirs has deterred some persons from purchasing the former volumes. These considerations have induced the Society to commence a second series, and they have accordingly denominated this the first volume of the series; it being also the sixth published by the Society since its Institution in 1781.

The Society wish it to be understood, as formerly, that they do not consider themselves answerable for the accuracy of the facts and reasoning in the several Essays: but that the responsibility rests entirely with the respective authors.

November 6, 1805.

LAWS.

I. THAT the Ordinary Members only shall be invested with the privilege of voting and electing Members; and that the whole expences of the Society shall devolve upon them.

II. That Gentlemen residing at a distance from Manchester shall be eligible into this Society, under the title of Honorary Members; provided no one be recommended who has not distinguished himself by his literary or philosophical publications.

III. That Gentlemen at a distance, who have favoured the Society with important communications, or from whom such contributions may be expected, shall be eligible, under the title of Corresponding Members.

IV. That every Candidate for admission into the Society, whether as an Ordinary, Honorary, or Corresponding Member, shall be proposed by at least three Ordinary Members, who shall sign a certificate of his being, from their knowledge of him, of his character, or of his writings, a fit person to be admitted into it; which certificate shall be read at not fewer than two successive meetings of the Society, previous to the evening of election.

V. That no election shall be made, either of Ordinary, Honorary, or Corresponding members, except at the Quarterly Meetings; and that notice shall be given to each Member, whenever a candidate is nominated.

VI. That every election shall be conducted by ballot, and that the majority of votes shall decide; and that the President shall have the determining voice, if the number of votes be equal.

VII. That when an Ordinary Member removes to a greater distance than twenty miles from Manchester, he may be entitled to the continuance of the privileges of the Society, by paying five guineas to the Treasurer, in lieu of his annual subscription.

VIII. That a President, four Vice-Presidents, two Secretaries, a Treasurer, and a Librarian be elected annually by the majority of Members present, on the last Friday in the month of April. The election to be determined by ballot.

IX. That a Committee of Papers shall be appointed by ballot, at the same time, which shall consist of the President, Vice-Presidents, Secretaries, Treasurer, and Librarian, together with six other Members of the Society; and that this Committee shall decide by ballot concerning the publication of any paper which shall have been read before the Society; and shall select, with the consent of the Author, detached parts of any paper, the whole of which may not be deemed proper for publication; but that the presence of seven Members of the Committee shall be necessary for such discussion or decision.

X. That Visitors may be introduced by any Member to the Meetings of the Society, with the permission of the Chairman.

XI. That every Member who shall favour the Society with communications, shall send them to one of the Secretaries, the Monday before the meeting of the Society.

XII. That the Secretary to whom the paper shall be delivered, shall, with the approbation of the President, or two Vice-Presidents, have the power of suspending the reading of it untill it be referred to a Meeting of the Committee of Papers, whose decision shall be final.

XIII. That all papers judged admissible shall be read by one of the Secretaries, or by the Author, in their order.

XIV. That no more than half an hour shall be allowed for the reading of any paper; and if the whole cannot be read within that time, the remainder (except the Society determine otherwise) shall be deferred till the succeeding evening. No paper however shall engage more than two evenings, without the consent of the Society, expressed by ballot, if required.

XV. That every Ordinary Member who produces a paper, shall therewith deliver a summary of its leading contents, which shall be read, paragraph by paragraph, after the paper to regulate its discussion.

XVI. That the Speakers shall direct to the Chair any observations they may make; and, if it be difficult to command immediate attention, it is desirable that they should stand up when they address the President.

XVII. That authors be requested to furnish the Society with an epitome of their papers, which may be read at the meeting succeeding the reading of each paper, and the discussion renewed.

XVIII. That each Ordinary Member shall pay one guinea annually, by half yearly payments, into the hands of the Treasurer, to defray incidental expences, and to establish a fund for the benefit of the Society. Each Member on his election to pay his subscription for the current half year, together with two guineas as an admission fee.

XIX. That each of the Vice-Presidents, in rotation, undertake his office, for one month; during which term e shall take the chair, in the absence of the President, at seven o'clock precisely: it is hoped that he will furnish articles of intelligence; and when no paper is before the

Society, it is expected that he provide a subject for discussion.

XX. That no laws shall be enacted, rescinded, or altered, but at the quarterly meetings, on the last Fridays in the months of January, April and October; and that notice shall be given, at least, fourteen days previous to those meetings.

XXI. That the Society shall publish a volume of miscellaneous papers, at least, every two years. And that, at stated times, the Committee shall select from the papers which have been read to the Society, such as shall appear to be most worthy of publication, but that no paper shall be published without the consent of the author. That every paper, voted for publication by the Committee of Papers, shall be sent to the press without delay; that notice of the printing shall be given to the author, and that he be entitled to thirty separate copies, on paying the extraordinary expences attending them.

XXII. That a Library be formed for the use of the Members of this Society, and that the Librarian be authorized to purchase such books as shall be ordered at the quarterly meetings of the Society; but that no books shall be taken out of the library, without leave of the Librarian, and that the time of keeping it be limited to seven days.

XXIII. That the resolution to establish a library be announced to the Honorary and Corresponding Members of the Society; and that it be intimated to them by the Secretaries, that donations of their past and future publications will be *highly acceptable.*

XXVI. That two SILVER MEDALS shall be given *annually,* one to the author of the best Essay on a Literary, and another to the best on a Philosophical Subject, which shall have been read at the Society during the course of the season; to be determined by the committee of Papers.

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ERRATA.

Page 145 line 5, insert *not* at the end.

179. line 5 of note, for *hero* read *Nero*.

MEMOIRS

of the

LITERARY & PHILOSOPHICAL SOCIETY

of

Manchester.

AN ESSAY,

Physiological and Experimental,

ON THE EFFECTS OF OPIUM ON THE LIVING SYSTEM.

BY

WILLIAM ALEXANDER, M.D.

Communicated by Samuel Argent Bardsley, M. D.

(READ FEBRUARY 15, AND MARCH 1, 1799.)

PART THE FIRST.

IN this Paper, which I have the honour to submit to the consideration of the Society, I propose to enter into an examination of two questions, viz. 1st. *Can the effects exerted upon the living system, by the operation of Opium, be accounted for, without the agency of the nervous system?* 2d. *What is the nature of that operation, whether sedative or stimulant?* This subject I do not select either because I have some new doctrines to establish, or because the generally received opinions concerning the operation of Opium, require ad-

ditional support, but rather because in the discharge of a duty for a long season neglected, I am obliged to have recourse to those means, which the present opportunity allows me.

In this disquisition, it may be considered, that I enter upon the investigation of a subject, which has already been rendered barren by the diligence of preceding enquirers, and that consequently nothing of novelty can be expected. It is not under this expectation that I take up the pen, for how much soever may have been effected, something yet remains to be done by the diligent and patient enquirer, and, though nothing could be gained beyond a confirmation of established opinions, yet if this be done through the means of accurate and frequently repeated experiments, something is added to the stock of information, and it must be considered at the least as possessing a relative value.

These experiments are not however destitute of some novelty in the arrangement, and they will be found to exhibit, in a clear analytical succession, the effects produced by opium upon the different parts of the animal machine. But it is not clear by any means, that the physiologists of this day are agreed upon many points, which will be brought forwards in this essay; and more is required to be done, before the subject can be considered as exhausted.

The humoral pathology, which had for a long space of time occupied the schools of medicine, had no sooner been called in question than a variety of opponents arose in every quarter against it; the new opinions being clothed in professional authority and enforced by the learning and genius of several private teachers, the tide of opinion flowed in a contrary direction, and it became the fashion to account for all, or most of the deviations from a state of health in the animal body, from some primary alteration in the condition of the solids. In many points the advocates for the new doctrines were notwithstanding at issue with each other, and the memorable contest betwixt Haller and Whytt, respecting the origin and nature of irritability, opened to the physiologist new sources of enquiry and laid new foundations for future improvement. The agency of the nervous system, which was still necessary for the explanation of most of the phœnomena upon the theory of diseased solids, began at length to be exploded by the advocates of another yet more refined and simplified, which the creative genius of John Brown ushered into the schools of physic.

This doctrine rejecting the explanation of diseases upon partial and confined theories, at-

tempted to refer all the various changes in the human body to one general law. He maintained the existence of a principle in the animated body, which he denominated Excitability; That this principle was characteristic of life; that action was the consequence of the operation of certain powers upon this principle, health the consequence of the due and proper operation of these powers, and disease the effect of too abundant or deficient action of these powers.

In this state of things the very accurate and most philosophical Thesis of Dr. Goodwin, upon the cause of death from suspension and submersion, made its appearance, in which he plainly proved the existence of a primary change in the condition of the blood; that this condition was sufficient, and indeed necessary to occasion death. About this period also the experiments of the celebrated Italian philosopher, Fontana, attracted considerable attention and became the subject of much discussion. He contended from numerous experiments, that opium was a power, which exerted a direct influence upon the blood, or that the blood was a necessary agent to communicate its operation to the living and irritable fibre, and without the circulation of which, the usual effects of opium could not take place.

His experiments, which excluded the agency of the nerves altogether in producing the general effects, resulting from the exhibition of opium, afforded considerable support to those who maintained some new doctrines of irritability. *(a)* This property was considered not only as not being derived from the nervous system, but capable of being encreased, di-

(a) These physiologists rejecting the nosology and practice of Dr. Brown as incompatible with his fundamental principles, but adopting these, and using the borrowed term of irritability instead of excitability, attempted to establish a new hypothesis, by explaining all the changes, which the body underwent in a state of health and disease, upon an alteration in this principle. The experiments of Fontana, which went to deny the influence of the nerves, coinciding with this new hypothesis were eagerly embraced by them.

The manner in which these physiologists explained the consumption of irritability upon the application of a stimulus, without the agency of the nerves was somewhat curious. They supposed the principle of irritability was like the matter of heat, diffusible over every part of a body endowed with it, that when any portion of it was destroyed by the action of a power applied to any part, the expenditure, thus occasioned, was supplied by the influx of a new quantity from the general stock in the system; thus the continued action of a stimulant power, keeping up a continued expenditure, there would be a succession of new influxes until the whole irritability of the body was consumed by the repeated wants of that part to which the destructive agent was applied.

minished, or exhausted by the application of external powers, which had no effect upon the nervous system, and that it was, to use the words of Dr. John Brown, as applied to his principle of Excitability, "Una toto corpore et indivisa proprietas."

To ascertain how far some of these opinions were consistent with the laws of the animal œconomy, I instituted a set of experiments, which formed the subject of an inaugural dissertation, published in the year 1790. It appeared to me in consequence of that investigation, that several of the above-mentioned opinions, viz. That opium did not act upon the nervous system; that it acted upon the blood; that its effects could be extended by means of the one and indivisible property of irritability, had been founded upon reasons which were very unsatisfactory.

This publication being calculated principally for the meridian of Edinburgh, was confined to that place, and the question, taken in a general point of view, was left undetermined.

Since that time I find, from the perusal of a work, called "Medical Extracts," written by a gentleman of some ability, but of more *imagination* than judgment; that the opinions of Fontana are not only sanctioned by respectable authority, but are considered as

generally known, understood and acted upon. I have, therefore, thought it necessary to collect into a short point of view the facts, related by Fontana, and the general conclusions he drew from them, and to compare them with the principal facts, established by the investigation above alluded to.

(b) " I destined, says Fontana, 300 frogs for these experiments and by means of pincers and scissars, I laid bare the crural nerves in such a manner, that they were entirely free of every other part, and obtained about 8 or 10 lines of nerve totally clear and in some very large frogs even more. I then let fall the nerves of each thigh into a small hollow glass, which received them in such a way that I can fill each glass with a fluid of any kind without its touching the adjacent musoles. I usually have been able to put into these glasses, such a proportion of whatever I wish to try on the nerves, as to cover the greater part of them with it, without its being possible for any of the liquor to find its way to the thighs and mix with the blood. In this way I can make a comparison betwixt the nerves, that are envenomed and those that are not; compute the

(b) Medical Extracts 630. Vol. 3.

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truth of it. I followed the method described by Fontana, and I found the fact to be correctly as he relates it; the divided extremity of the crural nerves, bared for the space of half an inch and immersed in solutions of opium of various degrees of strength, was not more affected than if the same nerves had been immersed in water, and the irritability of the muscles, to which they were distributed, was not in the least degree more altered.

Although I admit the accuracy of these experiments, I am inclined to call in question the sufficiency of them for the purpose they were designed. There is a considerable difference betwixt the sentient and the divided extremity of a nerve. This operation, even if the structure of the divided part was capable of receiving and communicating impressions, must in a great measure have had the effect of destroying its sensibility, and though the solution was not only applied to the divided extremity, but also enveloped the surface of the nerve for a considerable distance, this surface must also have lost in consequence of being separated from the muscles by " scissars and pincers", so much of the usual quantum of sensibility as to be unequal to transmit any effect produced upon it.

Respecting the second series of experiments, they are so contrary to all that repeated ex-

perience has taught, so contrary to the observations of Haller, Whytt and Munro, who, notwithstanding the difference of opinion they held, on some points connected with the operation of opium, unequivocally agreed on this head, (viz. that it destroyed the irritability) that I cannot but conjecture, some unobserved circumstances must have diverted the usual accuracy of Fohtana from its natural bias.

The conclusion drawn from the third series of experiments rests partly upon the accuracy of the second, and partly upon the supposition that the heart has not any nerves, which is concluded because the knife of the anatomist has not discovered them; but except this opinion is maintained upon some other ground, it can be considered only as a *petitio principii*; the want of detection proves nothing either way, as it is nothing more than an argument of non-existence drawn from invisibility. Further, the experiment proves too much; the animal died instantaneously, on the injection of the solution into the jugular vein; the circulation must of course be interrupted; by what means was this sudden, this momentary effect communicated to the distant parts of the animal?

I have thus stated the proofs and arguments founded upon them, adduced by Fontana, as

accurately and at as much length, as the limits of this paper will allow; let us now see how the case stands when reduced to the test of experiment.

Does Opium act upon the Irritability of the Muscular Fibre?

(d) *Experiment* 1.

The heart of a frog was immersed into half an ounce of an aqueous solution of opium, in the proportion of half a dram and six grains of opium to one ounce of water, of the temperature of 44°, whilst contracting 25 times in a minute. Two minutes after immersion, it contracted only 15 times in a minute: after 8 minutes the contractions had ceased, and could not be excited again by any mechanical stimulus.

(e) *Experiment* 2.

The heart of a moderate sized rabbit whilst contracting 23 times in a minute, was immersed into an ounce of the above solution, of the temperature of the room; four minutes after immersion, it exhibited eighteen con-

(d) Vid. p. 5, Inaugural. Dissertat. Exp. 1.
(e) Vid. Inaug. Dissert. p. 7, Exp. 4.

tractions in a minute; ten minutes after immersion, six or eight contractions, and after twelve minutes had entirely ceased, and could not be excited anew to contract.

(f) *Experiment* 3.

Another heart immersed in an ounce of a stronger solution, only exhibited three or four strong contractions, on the period of immersion and afterwards was irritated in vain.

(g) *Experiment* 4.

The heart of another rabbit was placed in a wine glass and three drams of the strong solution poured on, whilst contracting 50 times in a minute: after 8 minutes spontaneous contractions had ceased, but irritated with a needle a few contractions were excited: after the lapse of 5 minutes no contractions could be excited.

In order to examine how far the opium contained in the solution contributed to produce the above rapid exhaustion of irritability,

(f) Vid. p. 10. Inaugural Dissert. Exp. 7.

(g) Vid. p. 10 & 11. Exp. 8.

(h) *Experiment* 5.

The heart of a frog, contracting 24 times in a minute, was placed in half an ounce of water, temperature 44°. It continued to contract in the water for 16 minutes, and when removed, contractions could be excited in the organ, by mechanically stimulating it, for the space of *six minutes longer.*

(i) *Experiment* 6.

The heart of a rabbit contracting 50 times in a minute, was placed in water of the temperature of the room. It contracted spontaneously for 20 minutes, and when removed continued irritable for the space of 10 minutes longer.

Can the Effect of Opium be communicated to distant Parts independent of the Assistance of the Circulation?

(k) *Experiment* 7.

The sternum of a frog was carefully elevated and the heart removed, forty drops of the strong solution were injected into the stomach. In 15 minutes the animal was stupified and para-

(h) Vid. p. 6. Exp. 3. Inaug. Dissert.
(i) Vid. p. 8. Exp. 6.
(k) Vid. p. 28. Exp. 20.

lytic, in 20 minutes convulsed: after 40 minutes, voluntary motion had ceased: after an hour and ten minutes it was dead and the irritability in all the muscles *was destroyed.*

(l) *Experiment* 8.

Thirty drops were injected into another frog, after the removal of the heart; it lived an hour and 15 minutes, and after death the irritability *was exhausted.*

(m) *Experiment* 9.

Twenty drops were injected into a third: It lived an hour and twelve minutes, and the state of irritability was the same as in the preceding.

Does the quantity of Opium sufficient to occasion Death, effect this by inducing a Change in the condition of the Blood?

(n) *Experiment* 10.

By some former experiments No. 17 & 35 *(o)* it had been found that 33 drops of the solution of opium injected into the jugular vein of a

(l) Vid. Inaug. Dissert. p. 29. Exp. 21.
(m) Vid. p. 30. Exp. 22.
(n) Vid. p. 74. Exp. 46.
(o) Vid. p. 20 & 35.

rabbit would occasion death in the course of a few minutes and exhaust the irritability of the muscular fibre. Another rabbit was selected and 33 drops injected into the crural vein; no other effect resulted from this but some degree of stupefaction. Twenty-six minutes afterwards 33 more drops were injected into the crural vein of the other limb.

The animal in a short time became more languid, but was not convulsed; its pulse was rendered more slow and feeble, at the period of 36 minutes from the injection into the first crural vein.

Seven hours from the first injection, the animal was convalescent, and the day following it fed as usual.

The occasion did not offer to make a computation of the quantity of opium which would be necessary to kill a rabbit when introduced by a crural vein, but the omission of this does not detract from the force of the evidence which the above experiment supplies, that the cause of the death of the animal, when the solution is introduced by the jugular vein, must arise from some other state, than a change in the condition of the blood, and that the effect of opium must have been extended over the entire system, by other means than the circulation; for, what reason can be given why the mass of fluids should

not be altered, when the solution was introduced by the crural as well as by the jugular vein; but upon the other theory, the solution of this difficulty is easy, and accords with the whole series of experiments. *(p)*

The life of a rabbit cannot be sustained a minute without the action of the heart; when the solution of opium is injected into the jugular vein, it is applied to the inward surface of the heart, mixed with a very small quantity of blood, and can then exert effects upon that organ as instantaneously as if the heart was immersed in it, as in experiment 2d *(q)*, the action of opium being thus directed against the irritable fibre, the exhaustion of that part would immediately succeed, of course the animal must die; but when the same fluid is injected into the crural vein, it does not reach the heart until it has been mixed and diluted with a very considerable portion of blood, so that no quantity of blood which the heart could contain during one period of dilatation, would be impregnated with any great quantity of the solution of opium. The consequences therefore, which followed from the injection of opium into the jugular vein, supposing that it

(p) Vid. Inaug. Dissert. p. 119. Note C.

(q) Vid. Inaug. Dissert. p. 17. Exp. 14.

acted immediately on the heart, could not in this instance be expected to take place.

Does Opium act upon the Nervous System?

(r) *Experiment* 11.

A triangular piece of bone was taken from the cranium of a frog, and the dura and pia mater removed; eight drops of the strong solution were injected upon the brain; a few drops were lost. In one minute the animal was convulsed, in three minutes it was dead. On examination the irritability in every part of the voluntary muscles was destroyed, neither compression of the nerves nor mechanical irritation could excite any contractions in them. The heart had not lost its motion.

(s) *Experiment* 12.

In another experiment of the same kind, the animal was immediately and generally convulsed, and was dead in one minute. When the heart was exposed it was found contracting 42 times in a minute. The irritability of this organ was not lost until three hours after.

(t) *Experiment* 13.

A portion of the cranium of a rabbit was elevated in like manner, and 40 drops injected

(r) Vid. Inaug. Dissert. p. 49. Exp. 29.

(s) Vid. p. 50. Exp. 31.

(t) Vid. p. 51. Exp. 33.

on the surface of the brain. At first the animal appeared lethargic and tottered. After ten minutes it was violently convulsed, and in the space of one minute and an half more, was dead. When the thorax was opened the heart was found contracting with considerable force.

The irritability was exhausted in all the muscles subservient to voluntary motion; they were repeatedly irritated, but in vain.

In these experiments, it is clear, that opium has a very powerful and instantaneous action upon the brain, that it is diffused over the whole nervons system, evinced both by the general convulsions preceding death, and the total consumption of irritability in the voluntary muscles, and which was equally as complete as if the opium had been applied immediately to the parts themselves.

It was next examined, if when opium is introduced into some other organ, its effects are extended by the nervous system to distant parts.

(v) *Experiment* 14.

All the parts as near as possible to the pelvis of a frog, on both sides, were divided, leaving the ischiatic nerves uninjured. These were afterwards secluded from the air, by the di-

(*v*) Vid. Inaug. Dissert. p. 59. Exp. 38—39.

vided edges of the skin being drawn together by slender threads. Three frogs were experimented upon.

Twenty drops of solution were injected into the stomach of one frog. The animal lived four hours after.

On examination after death, the irritability was destroyed in all the voluntary muscles.

Into another frog thirty drops were injected: After 16 minutes the animal was convulsed; the extremities below the knee which had no communication with the superior part of the body, except by the undivided ischiatic nerves, were likewise affected by convulsions, and in two hours and ten minutes, the animal was dead.

The ligatures which united the divided edges of the skin of the thighs were then separated, and the ischiatic nerves exposed; they were compressed; the compression of the nerve on one side, produced a slight contraction in one of the muscles in the lower part of the limb, but when repeated, no contraction followed; the compression of the nerve of the other limb, occasioned no contractions. The irritability in all the other muscles was exhausted.

Into a third frog, prepared in like manner, forty drops were injected: After 15 minutes the animal was convulsed; after the space of

two hours it was dead. Compression of the nerves did not excite the least motion in any of the muscles beneath, and when the skin was removed, the application of salt was equally as ineffectual, not the slightest degree of contraction was rendered visible.

From the event of these last related experiments we are instructed, that the effect of opium is extended to the most distant parts of the body, although the only communication which remains between the extreme parts and the body itself, is by the continuity of nerves, and these palpably not in a state best adapted to convey impressions.

It yet remained to be examined if by any other communication the effect of opium could be extended to distant parts, if the supposed integrity and indivisibility of the irritable principle was capable of doing it.

(w) *Experiment* 15.

The spine of a frog was divided above that part from whence the nerves issue which supply the inferior extremities; care was taken not to wound any other part.

After this operation, the muscles of the inferior extremities retained their irritability, and though the animal had lost the power of volun-

(w) Vid. Inaug. Dissert, p. 62. Exp. 42.

tary motion in them, it had strength to drag them after its body.

Into the stomach of a frog thus prepared, forty drops of the solution were injected; seventeen minutes after, all the parts of the animal above the point of the division of the spine, were violently convulsed, and in one hour and forty minutes the animal was dead.

The upper part of the body was then separated from the lower, at the part where the spine had been divided, and the following was the state of irritability in the different parts.

To the muscles of the breast and those of the superior extremities, salt was applied, but without exciting the least contraction or motion.

The iliac nerves below the point of the division of the spine were compressed; vivid and frequently repeated contractions were excited in all the muscles of the legs and thighs.

This experiment was repeated several times and invariably presented the same result. All the muscles of the body above the point of the division of the spine, lost the irritability; on the contrary, below the point of division, the irritability of the muscles remained unimpaired after the death of the animal, as was rendered evident both by the compression of the nerves and the application of salt.

To examine these circumstances a little more minutely, another experiment was made.

(x) *Experiment* 16.

The ischiatic nerves were divided on both sides in a frog, near their exit from the pelvis; this operation does not render the limb entirely paralytic. The animal still possesses a voluntary power over the muscles of the thigh, in a considerable degree: The upper point of the leg is rendered nearly paralytic, the lower point of the leg and feet are rendered entirely paralytic.

Into the stomach of a frog, thus prepared; thirty drops of the solution were injected; after 21 minutes the animal was convulsed; the convulsions extended to the thighs; the legs and feet were not in the smallest degree affected by convulsions. In one hour and 18 minutes, the animal was dead.

The application of salt to the inferior extremities, the lower joints of the legs and feet, produced rapid and frequent contractions; the muscles of the thighs at the first did not contract, but after the salt had been applied some time; feeble contractions were excited. The salt applied to the muscles of the superior extremities and to those of the breast and back,

(x) Vid. Inaug. Dissert. p. 66. Exp. 44.

was incapable of exciting the smallest degree of contraction.

In this manner I submitted the experiments and opinions of the Abbé Fontana, to an accurate investigation, and I did not draw conclusions different from his without the conviction that the experiments which I have related were carefully made and many times repeated, and in the presence of those whose bias led them to favour the opinions of the Italian physiologist. I shall therefore conclude this part of the paper, with a general enumeration of the facts which have been ascertained.

The first series of experiments proves that opium applied to the muscular fibre (the heart) exhausts or consumes, the irritability of that organ. Vid. Exp. 1st. 2d. 3d and 4th.

The second series of the above quoted experiments proves that the effect of opium is transmitted to distant parts of the animal body when the agency of the circulation is both withheld and destroyed, and in as rapid a manner as when the circulation of the blood is entire and vigorous. Vid. Exp. 7th. 8th and 9th.

The third proves to a certain extent, that opium either does not exert any immediate

action upon the blood, or that this fluid is an insufficient medium to convey it to distant parts of the system. Vid. Exp. 10th.

The fourth series proves that the effect of opium is directly exerted upon the nervous system. Exp. 11th, 12th, and 13th. That in proportion to the unity and integrity of this system, the effects of opium are extended to distant parts. Exp. 8th and 9th. That where this integrity is only partial, the effects are only partial. Vid. Exp. 16th. That where the integrity is interrupted, the effect of opium is interrupted. Exp. 15th. And finally, that the *una et indivisa proprietas* of irritability is inadequate in any degree to extend or communicate the effects or operation of the above-mentioned power *(y)*.

(y) In the Dissertation which has been so often quoted, the above experiments will be found supported by many others, the tendency of all which verge to the same point. In that, the general criterion which was established to denote the influence of opium, was founded on the observation of convulsions preceding death, and the loss of irritability in the muscular fibre after death. The quantity of this remaining was denoted by the frequency and strength of the contractions upon the application of common salt. It was, after many trials with other substances, found to be the most certain and effectual test. The manner in which salt produces this effect is no less beautiful than singular. It does not so much appear to

PART THE SECOND.

What is the nature of the operation of opium?

Ever since the introduction of this most powerful and efficacious article into the list of the Materia Medica, much diversity of opinion has arisen amongst medical men, respecting the qualities it possesses. It would be foreign to our purpose to enter into a discussion respecting the various theories which at different times have prevailed upon this subject, as experience and a clearer insight into the nature of the animal machine, have exploded all other opinions except two (opposite indeed to each other), namely, the one which explains the operation of this power by attributing a stimu-

excite a muscle to contract, because a certain portion of irritability is present, as it appears to bestow irritability, if this principle is not too much extinguished and the vitality gone. A muscle which is incapable of contracting on the application of a mechanical stimulus, and is relaxed and pale, will, on the application of salt, exhibit very frequent and strong contractions, assume gradually a beautiful florid colour, and will then become obedient to other stimuli, to which before it was insensible. Thus it will be found to be a better restorer of irritability to the muscular fibre, than muriatic acid, related by Humbolt.

lant quality to it, and the other which contends that the effects of its use prove it to be a sedative.

That it is of much importance to ascertain which of these opposing theories approaches to the truth, is evident from this consideration, that while the advocate for the stimulant effect of this power, will hesitate in the administration of it, in those states of the body which indicate an encrease of action, the supporter of the sedative effect, will boldly trust to it, as the best and most effective means to remove or diminish that condition of the system. And, indeed, such is the imperfect state of medical science, that neither party will be in want of great and respectable medical authorities in support of the two opposite modes of practice.

To arrive in some degree at a solution of this difficulty, and to attempt to establish the operation of opium on a more secure basis, is the design of the following pages. In this pursuit, I shall confine myself principally to the investigation of the effects of opium by experiments made upon the living and healthy animal. If at any time doubtful appearances take place, which render the effects obscure or not easily referable to either opinion, an explanation will be attempted, by calling in the assistance of that analogy which may be drawn from the

effects of those powers whose operation is universally acknowledged. For instance, if it be found that opium destroys the action of a muscular fibre on the instant of its application, and it be contended that this affords *primâ facie* evidence of its power to diminish action, and consequently that it is sedative, I should be induced to examine what are the appearances presented on the application of æther or spirit of wine to a similar muscular fibre, and if it be found that these powers destroy action in like manner as was effected by opium, the conclusion would be, that the single effect of diminished action does not constitute a positive fact favourable to either side of the question.

To bring the point at issue into as narrow a space as possible, it might be thought proper that I should give some definition of the terms sedative and stimulant: If mankind were agreed about the meaning of words this might not be difficult to do, but to avoid any unnecessary difference of opinion, and as it is proposed to investigate certain points by the way of experiment, I would defer any definition of the above terms until such facts are established as will obviate any ambiguity.

CHAPTER I.

The effect of different powers applied to the Hearts of Animals whilst in the Thorax and in a State of Action.

EXPERIMENT 1.

The sternum of a full grown frog was raised and the heart exposed;

Hours.	Minutes	
1.	35.	Ten drops of water containing a grain of opium in solution were poured upon the heart, beating 61.
	38.	The action of the heart has greatly diminished; contracting not more than 45 in a minute.
	45.	Contractions not more than 38.
	50.	Contractions 29 in a minute, and feeble.
	—	Ten drops more of the same solution (i. e. one grain) were poured upon the heart.
	55.	Heart contracts 28 in a minute.
2.	—	Twenty-eight contractions in a minute.
	10.	Not more than 20 contractions in a minute: animal beginning to be convulsed.

Hours. Minutes.

30. Convulsions when the animal is touched, the heart contracts very feebly and very slow.

50. No motion can be excited in the animal by irritating it, but the heart still continues to contract. The heart did not cease, until 27 minutes after.

4. 27. When the application of a mechanical stimulus produced no effect, either upon the heart or any of the organs of voluntary motion. 2^h 52^m: Opium 2 grains.

EXPERIMENT 2.

The heart of another frog was exposed in the same manner as the preceding: It beat 59 in a minute.

H. M.

1. 45. Five drops of the same solution containing half a grain of opium were poured upon the heart. An instantaneous diminution of motion succeeded.

48. Heart beats only 30: the animal struggles violently: the heart experienced a temporary cessation of action during the struggles.

Hours. Minutes.

53. Heart beats 28 in a minute: animal continues to struggle: the pulsation was not numbered again until

2. 3. It beat 28, and stronger in appearance.

8. Five drops more were poured on, heart beat immediately after only 24.

13. 23 Contractions in a minute.

23. 21 Contractions in a minute.

33. 16 Contractions in a minute.

53. 16 Contractions, or 17.

3. 3. Heart beat 12 in a minute: The animal convulsed when touched: It was not dead earlier than two hours and an half from this time. 3^h. 48^m.: Opium 1 grain.

EXPERIMENT 3.

H. M.

2. 30. The heart of another frog was prepared as the foregoing: ten drops were poured upon the heart, formed with eight drops of water and two of the solution computed to contain 1-5th of a grain. The heart beating 60 in a minute. Animal struggled violently.

Hours. Minutes.

35. Heart feeble and beating only 53.
40. Only 50 contractions, but they appear more strong and vigorous.
45. 43 Strong contractions in a minute.
50. One drop of the solution with four of water were poured on,
55. Heart makes 40 strong vigorous contractions.

3. 10. 43 Strong and vigorous contractions.
15. 47 Strong and vigorous contractions.
40. Only 39 contractions in a minute.

After this the contractions appeared to vary with the struggling of the animal: it was not dead at six o'clock; had never been convulsed, and was then killed.

EXPERIMENT 4.

H. M.'

Heart exposed as before beating 54.

3. 35. One drop of the solution and nine of water, computed to contain 1-10th of a grain of opium were applied to the heart. Little or no struggle ensued.
38. Heart beats 59 in a minute: and contractions apparently more strong.
43. Heart beats 61; strong contractions.

Hours. Minutes.

48. Heart beats more feebly, not more than 56 in a minute.

53. Heart still beats 56 in a minute.

4. — Heart beats no more than 47: animal struggles; the heart is always slower for one minute after struggling.

5. — Heart beats 52.

6. — Heart beats 49.

The animal was now killed, as nothing further could be collected from permitting it to live.

EXPERIMENT 5.

Upon an heart beating 58, the same quantity of the solution was poured on at $4^{h.}$ $15^{m.}$: i. e. 10 grains.

H. M.

4. 15. The animal struggled.

17. Heart beats 56 in a minute.

20. Heart beats 58.

25. Heart beats only 46, but the contractions are strong.

35. Heart beats 48: Five more drops of equal strength were poured on.

40. Heart beats 48, with little difference in strength.

45. Heart beats 48: strong and vigorous contractions.

Hours. Minutes.

6. — Heart beats 50, it continued to beat strong and vigorous, for some hours; when the animal was killed.

EXPERIMENT 6.

Upon the heart of another animal, ten drops were poured, which contained by computation only one-twentieth of a grain of opium, (a) after the application, the contractions were encreased from 50 to 54: After this they varied every five or six minutes, and continued near 50 for more than five hours, when the animal was killed.

EXPERIMENT 7.

Cold water was applied to a heart beating 56. The contractions immediately became less frequent, not more than 49: After five minutes, they rose to 57, and after ten minutes, were beating 61.

EXPERIMENT 8.

A second application of cold water to another heart, beating 53, after being exposed, appeared to encrease the contractions which were counted.

(a) This solution was made by putting one drop of the solution of 1gr. to 10grs. into 20 drops of water.

immediately after the application, to 58: After five minutes, they were 62; but they varied much as the animal struggled.

EXPERIMENT 9.

With Opium repeated.

A solution was made which contained one grain in thirty drops.

Hours.	Minutes.	
3.	12.	The heart beating 52, ten of the drops were poured on.
	14.	Heart beat no more than 49.
	16.	Heart beat only 36.
	18.	Heart beats 36; animal struggles: It continued nearly the same till
5.		five o'clock, when ten more drops were poured on. These were not attended with any perceptible alteration.
5.	25.	Heart beats 26, ten more drops were poured on: these did not either make any visible change.
	30.	Animal violently convulsed when touched.
6.	15.	Only 18 very feeble motions are now exhibited: convulsed when touched as before. The convul-

Hours. Minutes.

sions appear to make very little alteration in the pulsation of the heart.

50. Feeble convulsive motions when irritated: Heart beats feebly 17.

7. 45. No motion of any kind can be excited, whatever part is irritated with the point of a needle or knife, the heart yet moves.

8. — The heart yet moves very feebly, about 15 or 16 times in a minute. The skin of the extremities was now removed, and salt applied to the bared muscles. No contractions ensued; the crural nerves were then exposed, and compressed, but no contractions followed, in the muscles below. The heart moved feebly 15 minutes after this operation.

EXPERIMENT 10.

With Spirits of Wine.

H. M.

5. 35. The heart of a frog was exposed, and whilst beating 56, twenty drops of spirit of wine rectified, were poured upon it. The pulsation instantly diminished.

Hours. Minutes.

36½. The heart is quite motionless. The contractility of this organ was never recovered again, but the extremities were contractile near two hours after.

EXPERIMENT 11.

Upon the Heart of another Frog beating 58.

H. M.

6. 2. Five drops of spirits of wine with five drops of water were poured.

5. Heart beating 48; the animal struggles.

20. Five drops more were poured on, the motion of the heart instantly diminished.

22. Heart beats only 30.

40. Heart yet beats 29, or 30.

50. Heart beats only 26. The extremities are contractile, but not greatly so.

7. 10. Heart beats not more than 18, or 20; extremities are not contractile when stimulated.

30. Animal quite dead, no contractions could be excited in any part by the application of any mechanical stimulus.

EXPERIMENT 12.

With Æther.

Hours. Minutes.

8. — The heart of a frog exposed, beat 56. Twenty drops of vitriolic æther were poured upon it, after the first three drops were poured on, the heart ceased to pulsate for two minutes.

3. It exhibited a few feeble motions.

4. It had entirely ceased: the stimulus of the point of a lancet did not excite any motion: the extremities were contractile an hour afterwards.

EXPERIMENT 13.

H. M.

8. 50. Upon a heart beating 60, ten drops of vitriolic æther were poured and ten of water, the heart ceased to move after the first five drops were poured on.

51½. It exhibited 25 feeble contractions.

53. Heart was without motion, and did not contract on the application of a needle and lancet.

The extremities contracted afterwards for an hour and an half when stimulated.

From these foregoing experiments, no conclusions appear admissible, which can assist the elucidation of the question.

In experiments 1st, 2d, 3d, and 9th, the action of the heart was indeed instantaneously diminished, notwithstanding this, they are incompetent to establish an opinion, that opium is sedative, because the same effect followed, and in greater degree, the application of æther and spirits of wine. The 4th experiment exhibits somewhat the appearance of a stimulant operation, from the application of opium, and if the encreased number of pulsations of the heart could be fairly referable to the opium alone, the fact would have great force. When the sternum of a frog is first raised, the heart generally suffers a temporary diminution in the number of pulsations in a minute, and it not unfrequently happens likewise, that the struggles of the animal occasion a momentary suspension of the pulsation; when exposed to the air for a few minutes, or after being at rest, the heart generally recovers a greater force and frequency of pulsations.

To this cause, as well as to the effect produced by opium, may the encreased action of the heart be attributed. The same effect also followed the application of water, but this favours somewhat the supposition, that the

effect in experiment 4, was owing to a stimulant operation, for such would be the application of water. The temperature of a frog is only 44, the temperature of water was equal to that of a room within doors, which was not less than from 60 to 70. The frequent variations of the pulse which occurred from the struggles of the animal, would likewise greatly diminish the force of any conclusions which might be drawn respecting the effects of any of the powers applied. The only deduction which can fairly be admitted is, that no difference of effect was observable betwixt the application of opium and strong stimuli, sufficient to justify an opinion that these powers had a different operation.

Rabbits were the Subjects of the next Experiments.

EXPERIMENT 14.

The Thorax of a full-grown rabbit was opened, and the heart exposed by the removal of the sternum. The animal was seized with convulsions, and died in the space of one minute. The contractions of the heart continued, for more than half an hour after.

Hours. Minutes.

10. 21. The ventricles had ceased to move, the auricles yet exhibited a feeble vibratory motion.

31. The left auricle was without motion: In the right auricle a tremulous motion was observable, once or twice in a minute. Ten drops of a solution of opium which contained 1 grain in 16 of water, were poured gently upon the heart. Several encreased contractions of the ventricles followed in quick succession.

35. The heart was again motionless in every part.

36. The solution was poured on again in the same quantity, but produced only one contraction, in the right auricle.

10. 37. The pericardium was stripped off: a feeble motion was excited by this cause, in the right auricle. When the heart was again at rest, the solution was a third time applied; two or three quick contractions followed.

Hours. Minutes.

40. Contractility of the heart entirely exhausted: no motion could be excited, either by opium or any mechanical stimulus.

EXPERIMENT 15.

With Water.

To examine if the encreased contractions which followed in the last experiment the application of opium to the heart, were referable to the quantity of opium, or were to be ascribed to the mechanical stimulus of the bulk of the fluid applied; the thorax of another rabbit was exposed, and after the ventricles had ceased to move, the right auricle exhibiting a tremulous motion as in the last. Ten drops of water equal in temperature to the solution were poured on, but without any contraction being excited: It was applied a second time, and with as little effect.

EXPERIMENT 16.

With rectified Spirits of Wine.

The thorax of a rabbit was opened; after the animal was dead, the heart continued to contract with considerable force, 55 in a minute.

Hours Minutes.

12. 40. Ten drops of spirits of wine rectified, with five of water, were poured on the heart whilst contracting: Force and frequency of the contractions surprizingly encreased to 90 in a minute.

40½. 43. The contractions were diminished both in force and frequency; no more than 78.

49. The pericardium was stripped off: Spirits of wine diluted with the same quantity of water, were again poured upon the heart.

53½. The contractions became a little more numerous, 75.

55. A small orifice was made into the right ventricle, and thirty drops of spirits of wine were injected.

The contractions ceased instantaneously and could not be excited again, by the application of any stimulus.

EXPERIMENT 17.

With Opium.

The heart of another animal was exposed as the preceding.

Hours. Minutes.

1. 5. Ten drops of the solution (i. e. half a dram of opium to one ounce of water) were poured upon the heart whilst contracting 60.

5½. Contractions encreased both in force and velocity, to 78.

7. Contractions abating of their force and frequency, 65.

— The pericardium was stripped off.

8. Solution of opium applied again in the same quantity.

8½. Contractions visibly encreased to 72.

10. The ventricle was perforated with the point of a knife, the heart still contracting with force; thirty drops of the solution were injected into the heart: motion diminished almost instantly, one or two contractions appearing after the injection of the solution, but not more. The point of a knife and lancet, applied afterwards, did not excite any motion.

EXPERIMENT 18.

With Æther.

The heart of another rabbit was exposed, and whilst contracting with great force.

Hours. Minutes.

2. 10. Ten drops of æther with five of water were poured on: encrease of contraction followed, but not so observable, as on the application of spirits of wine, or opium.

2. 14. The pericardium was taken off and the same quantity applied again, an encreased force of contractions was evident. The heart contracts much slower than after the second application of opium or spirits of wine, to the aforementioned animals.

2. 17. A small perforation was made in the heart, 30 drops of æther were thrown in; motion ceased instantly, and no contractions could be excited by mechanically stimulating the heart.

EXPERIMENT 19.

Ten drops of the spiritus volatilis aromaticus were applied upon another heart, in a similar

condition with the foregoing, which was followed by an encrease both of force and frequency in the contractions; after the injection of 30 drops into the cavity of the heart, the same loss of contractility was apparent.

EXPERIMENT 20.

The thorax of another rabbit was opened, and after the convulsions had ceased at

Hours. Minutes.

5. 31. Ten drops of water were poured upon the surface of the heart, whilst contracting with force, but no apparent alteration was produced.

33. The contractions have not diminished in frequency, but the force appears less.

34. The pericardium was stripped off: Contractions greatly augmented by this operation.

36. Water applied again, a slight diminution of contractions ensued.

38. Contractions very frequent, but feebler.

39. A few drops of water applied again; a momentary diminution of contractions ensued.

Hours. Minutes.

41. Contractions have returned to their former frequency, but the force greatly diminished.

The right ventricle was perforated, and 30 drops of water injected; they appeared to make little or no alteration. The contractions had not ceased 51 minutes after this time.

In these last enumerated experiments, the following similar effects were observable, from the application of æther, spirits of wine, spiritus volatilis aromaticus and opium.

1st. Encreased force and frequency of the contraction of the heart upon the application of the above-mentioned powers to that organ.

2d. A diminution of force and frequency, in the contractions, in the space of two minutes afterwards.

3d. The same effect, but in a less degree, produced upon the second application of the same substances.

4th. The entire cessation of motion in the heart when the same substances were injected into the cavity, in a quantity greater than what was applied to the surface of the heart.

From this last consideration, I am inclined to attribute the different effects, i. e. the encreased action in the first instance, and the diminished action in the second, which appear on the ap-

plication of the same substance in a smaller and larger quantity, not to any difference of operation in the substance itself, but as referable to the condition of the organ acted upon, and quantity of power acting upon it.

SECTION 2.

Opium, Spirit of Wine and the Spiritus Volatilis Aromaticus, thrown into the stomach of Animals.

EXPERIMENT 21.

The skin was dissected from the thorax and upper part of the abdomen of a frog. The heart could distinctly be perceived to beat through the integuments, 56 in a minute.

Hours.	Minutes.	
11.	34.	Thirty drops of a solution containing three grains of opium, were thrown into the stomach by a small glass tube.
	37.	Heart beats no more than 45: animal feeble.
	42.	Heart beats so feebly that it can scarce be numbered:
12.	—	About 30 the animal convulsed: Its hind legs extended.

Hours.	Minutes	
		The heart cannot, through the integuments, be discerned to beat.
1.	—	The animal lies in a state of stupefaction, and is convulsed when touched.
3.	57.	Animal was dead.

EXPERIMENT 22.

H.	M.	
		The heart of a frog beating 58.
6.	12.	Ten drops of a solution containing one grain of opium, were thrown into the stomach.
	14.	The heart beats not more than 54.
6.	17.	Heart beats 52, but the animal does not appear to be much enfeebled.
	22.	Heart beats no more than 36, and very feeble.
7.		The heart was beating 43, and more strong; the animal active.
	36.	The heart beats 48; the animal was then put into water, and the following day was alive, but with the appearance of being weaker than usual.

EXPERIMENT 23.

Hours. Minutes.

9. Five drops of the solution containing half a grain, were thrown into the stomach; heart beating 59.

4. Heart beats 54, but the animal did not appear to be much affected.

10. Heart beats 49.

20. Heart beats 52; the animal was then set at liberty.

EXPERIMENT 24.

Into another frog one-fourth of a grain of opium was thrown. Heart beating 60.

Two minutes after, it beat 59.

Five minutes after 54; after ten minutes, 54; after twenty minutes, it beat 55; after half an hour it beat 57; after two hours it was beating 5

EXPERIMENT 25.

Into the stomach of another frog one-eighth of a grain of opium was thrown. Heart beating 58.

After two minutes it beat 58.

After five minutes it beat 62.

After twenty minutes 59.

After an hour it beat no more than 50.

After an hour and half, it beat 55. The animal was set at liberty.

EXPERIMENT 26.

With Spirits of Wine.

Hours.	Minutes.	
11.	18.	Thirty drops were injected into the stomach of a frog.
		Heart beating 60.
	20.	The heart more feeble: It cannot be numbered to 40.
11.	25.	Heart beating feebly 25.
	28.	The animal extremely feeble; appears lethargic. Heart has ceased to move.
		The animal continued in this state four or five hours. The extremities had, in a great measure, lost their contractility.
6.	—	The animal was dead: on baring the muscles they could not be excited to contract.

EXPERIMENT 27.

Into the stomach of another frog, two drops diluted with ten of water, were thrown.

Hours. Minutes.

5. — Heart beating 58.
5. Heart beat 56.
10. Heart beat 50, but the animal did not appear to be enfeebled.
20. Heart beating 50, no further observations were made upon it.

EXPERIMENT 28.

Into another—One drop of spirits of wine was thrown, with ten drops of water: but it could not be observed, if any alteration was made by it upon the heart of the animal.

EXPERIMENT 29.

With Æther.

The heart of a frog beating 57.

H. M.

10. — Thirty drops of æther were thrown into the stomach.
2. Heart beat 50.
5. Heart beat 46, and the animal appeared weaker.

Hours. Minutes.

10. The heart could not be counted. The animal was dead at

1. 20. The muscles were then bared and stimulated, but no contraction could be excited.

EXPERIMENT 30.

Into the stomach of another frog, two drops of æther mixed with ten of water were thrown.

H. M.

11. — Heart beating 60.

5. Heart beat 58.

20. Heart beat 57.

30. Heart beat 52, and feeble.

35. Heart beat 49.

12. — Heart was beating 56; no other observation was made upon it.

These experiments furnish no other conclusion except that opium, æther and spirits of wine, when thrown into the stomach of frogs, in such quantity as to produce any considerable change in the animal, all of them equally diminish the velocity of the pulse. The effect appeared to be analagous to the experiments made with the same animal in Section 1st. and are equally as inconclusive.

Recourse was then had to other animals.

EXPERIMENT 31.

With Rabbits.

The heart of a full grown rabbit beats generally from 260 to 270 in a minute. (b)

Hours.	Minutes.	
3.	9.	An ounce of spirits of wine was injected down the œsophagus.
	12.	Pulse 288, but not considerably stronger.
	16.	Animal is very dizzy, and staggers when he attempts to walk.
	20.	Pulse encreased to 312: animal appears completely drunk.
	30.	Animal lethargic, with its eyes open.

(*b*) The velocity of the pulse of a rabbit has not unfrequently excited some degree of surprize, and it has been suggested that at so high a point of number, the feel could not be so accurate as to discriminate the exact number of pulsations. At the time these experiments were made, by frequent application I was persuaded, that in the counting, I was not wrong more than so few in number as not to make any difference in the general conclusion, which was all that was aimed at; but that I might avoid error as much as possible, I requested Dr Goodwin, whose accuracy is unquestionable, to mark the pulse in all these substances, whilst I noted down from time to time his report.

Hours.	Minutes.	
	45.	Animal somnulent.
	80.	Pulse has fallen to 264, but continues yet strong.
5.	30.	Animal in a state of great insensibility. Its eyes are yet contractile, when irritated moves its feet now and then, and is affected with convulsive tremors: Pulse quick, but remarkably feeble.
6.	30.	The eyes have lost much of their contractility, and are beginning to be watry.
	9.	Until this period, the animal continued to lie in a state of great insensibility, without any particular change. The heart so feeble as not to be numbered.
	30.	No sign of life appears except a little feeble respiratory motion in the thorax.
11.	10.	The motion in the thorax has entirely ceased.

N. B. The animal was dead after eleven hours and nine minutes.

EXPERIMENT 32.

The experiment was repeated with a young rabbit; the heart beat 264 in a minute.

Hours. Minutes.

5. 30. An ounce of spirits of wine was thrown into the stomach.

34. The pulsations of the heart have encreased to 308 in a minute. The animal appears drunk, and can scarcely support itself.

45. Animal in a state of somnolency,

50. the pulse so feeble as not to be numbered.

5. 30. No perceptible material change in the animal before this period: The pupils of the eyes now have lost their contractility, and an effusion of water appears on the surface of the cornea: The motion of the thorax so feeble as to leave it doubtful if respiration was going on.

40. The animal's respiration has ceased.

44. The voluntary muscles were examined, but no appearance of contractility was evidenced upon stimulating them. When the thorax was opened, the heart possessed a very feeble motion, but not so great as to merit the name of a contraction: It ceased to move in four minutes after being exposed.

N. B. This animal, which was young, lived only two hours and fourteen minutes, after the spirit of wine was thrown into the stomach.

EXPERIMENT 33.

With Æther.

Hours. Minutes.

1. 21. An ounce of æther was injected down the œsophagus of a middle-sized rabbit: heart 272.

22. Within a single minute the abdomen was very tumid, and distended apparently with air. The heart is already more slow and feeble.

1. 25. The abdomen continues to swell; the animal prostrate and unable to move.

27. Animal cries, and appears in great pain. Heart more feeble, and cannot now be numbered. The animal has entirely lost the use of its limbs.

33. The animal dead.

The abdomen was opened: The stomach and intestines appeared distended to an amazing

size; they were punctured, and as the air escaped, a lighted candle was applied and it caught fire.

There was no contractility in any of the voluntary muscles: when the heart was exposed the ventricles were without motion: but the auricles exhibited a feeble pulsation.

EXPERIMENT 34.

With Spiritus Volatilis Aromaticus.

An ounce was injected into the stomach of a full grown, and the same into the stomach of a young rabbit.

The pulse of the eldest when the injection was made, beat 260 in a minute.

After three minutes it beat 312, and with proportional encrease of strength.

After nine minutes, it beat no more than 276: but considerably stronger than before the injection:—The animal was now unable to stand.

After nineteen minutes, the pulse was so feeble as not to be numbered:—The animal lived 14 hours and 23 minutes after the injection.

The pulse of the younger animal, when the fluid was thrown into the stomach, was 274 in a minute.

After two minutes the pulse rose 286 and was stronger; after six minutes, it had fallen below its natural standard and was become very feeble.

This animal lived only two hours and 14 minutes: on examination after death, no contractility was evident in any of the voluntary muscles. The thorax was opened; the left side of the heart was motionless, but a slight quivering was evident in the right side.

EXPERIMENT 35.

With Opium.

Hours.	Minutes.	
1.	14.	Half an ounce of the solution was thrown down the œsophagus of a full grown rabbit, the heart beating 270 in a minute.
	49.	The heart beats with great force and velocity, 310 in a minute.
2.	—	Heart beats about 300 in a minute.
	30.	Heart has become more feeble; beats no more than 240 in a minute.

Hours.	Minutes.	
3.	5.	Pulsations considerably more feeble; not more than 180 in a minute.
	50.	Animal not able to support itself; appears to be asleep; affected with universal tremors.
4.	—	Pulse so feeble as not to be numbered.
5.	20.	Animal in a state of insensibility, not capable to be excited to motion, on the application of violent mechanical stimulus.
6.	55.	No pulsation to be distinguished; the animal yet respires, but in a slow and laborious manner.
	10.	The animal little altered from the last report; the eyes are watry.
		The animal died during the night, and no opportunity was allowed to examine it after death.

EXPERIMENT 36.

Repeated with a Young Rabbit.

H.	M.	
2.	17.	The same quantity thrown into the stomach of a young animal; heart beating 264 in a minute.
	20.	Pulse remarkably strong; encreased in a velocity to 288 in a minute.

Hours. Minutes.

30. Pulse has fallen to 264, but still continuing strong.

35. Animal in a state of ebriety; has lost all command over the voluntary motions: pulse 250.

37. Animal begins to be convulsed: the pulse now so feeble as not to be numbered, with regularity.

39. Convulsions which had remitted for about half a minute, now returned again.

40. Animal died convulsed.

On examination after death, none of the muscles subservient to voluntary motion possessed any contractility.

When the thorax was opened, the right side of the heart exhibited a very feeble motion.

EXPERIMENT 37.

The same was repeated upon a young and old dog, with an ounce of the solution of opium.

The young dog died eight and forty hours before the older animal.

In these last experiments, a very striking analogy subsists between the effects of opium and those of powerful stimuli, with which it

was compared; the principal points in which they agree are the following:

1st. An encreased action of the heart and arteries, succeeding the introduction of the several substances into the stomach of rabbits.

2d. This encreased action being evident more early in young than in the full grown animals.

3d. The succeeding diminution occurring sooner in the young, than in the adult animals.

4th. The more speedy death of the young, than the full grown animals, from equal quantities of the several substances taken in.

5th. The entire destruction of contractility in all the voluntry muscles and a diminution of it, almost amounting to exhaustion in the heart after death, from the action of the several substances introduced into the stomach.

These experiments, which may be concluded as positive facts, not only serve to elucidate the question, but have a more wide influence; they lead to an explanation of the defect of appearance of encreased action, when the same substances were applied to the hearts, and injected into the stomach of frogs.

Before any attention is paid to such explanation, we shall continue the analogy somewhat further, and notice the most striking of

the experiments, which have been brought forwards in support of the opinion,—that opium was sedative. The opinion of the celebrated Whytt, was at all times weighty, and he strengthened his arguments in favour of the sedative influence of opium, by a remarkable quotation drawn from the thesis of Dr. Bard, *De Opio*. Not being able to procure that Dissertation, we shall quote the passage from Dr. Whytt, as he gives it.

" At seven A. M. Dr. Bard took one grain " and a half of opium, his pulse beating 71 in " a minute. At 8 A. M. his pulse beat 69; " at 8¼, pulse beat 67; at 8½, pulse beat 66; " at 8¾, 66; at 9, 64; at 9½ after breakfast, " it beat 66; at 10, 65; at 11, it beat 61; at " 11¼, it beat 60; at 11½, 59; at 12, 57; and " this was the lowest to which his pulse ever " fell.

Dr. Whytt insists very strongly upon this experiment; yet, that it is defective in point of proving any thing in favour of his opinion, is very evident by a little attention to it. Dr. Bard took the opium at seven in the morning; he measured his pulse for the first time at eight, he then concluded that the state of his pulse at that hour was to be attributed to the primary effect of opium upon the body. To point out

the insufficiency of this experiment, it is only necessary to advert to experiment 36.

Had the pulse, in that experiment, been omitted to be examined for the space of eighteen minutes, and a conclusion drawn from the effects which were at that period observed, it would have been a conclusion favourable to the opinion which Dr. Whytt maintained: But that conclusion would not have been agreeable to what was fact; for, the pulse, previous to that period, had arisen more than 20 beats in a minute. It would have been to substitute for the primary effect of opium, that effect which took place when its primary action had begun to diminish, and to have mistaken a condition which that action had left behind, for the action itself. To put this point, however, out of doubt, it was necessary to repeat the experiment, and with that degree of observation which Dr. Bard appears to have neglected, and to prosecute likewise at the same time, the analogy with æther and the other substances.

EXPERIMENT 38.

(c) On the Human Pulse.

Hours.	Minutes.	
9.	—	Upon an empty stomach before breakfast, Mr. Fleming took half an ounce of spirits of wine diluted with a little water. Pulse 78.
	10.	No alteration in the pulse: a sense of warmth at the stomach.
	20.	Pulse 82, and considerably more full: an evident exhilaration of spirits.
9.	35.	Pulse 82, and continuing equally full.
	48.	Half an ounce more was given him: Pulse 80.
10.	—	No further encrease in his pulse, which still remains 80.
	35.	Pulse has now fallen to 70, but yet feels more full than at the first, a little sense of heaviness in the head: a slight sensation of heat in the stomach.

(c) In these experiments likewise, I was indebted to the friendly assistance of Dr. Goodwin, who made the report in Exp. 38, 39, 40, 41 and 42.

These soon disappeared and left no disagreeable consequences behind.

EXPERIMENT 39.

Mr. Gerard, at the same time, took upon an empty stomach two drams of vitriolic æther.

Hours. Minutes.

9. — Pulse 64, and feeble.
5. Pulse 68, and considerably more full.
15. Pulse 72, very strong; agreeable sensation of pleasure. Warmth at the stomach.
45. Pulse has diminished to 68.—He took two drams more.
59. Pulse not more than 68, but yet full and hard; a little head-ach, sense of heat and nausea at the stomach: notwithstanding this, he experiences a degree of exhilaration.

10. 25. Pulse 66, but no sensation of uneasiness.
45. Pulse 66; some degree of nausea.
55. Pulse 62. The nausea gone off; no uneasy sensation.

EXPERIMENT 40.

Hours.	Minutes.	
9.	10.	Upon an empty stomach before breakfast, pulse 72, and feeble, another gentleman took half an ounce of spiritus volatilis aromaticus.
	20.	Little alteration has been perceived in the pulse.
	25.	He took five drams more of the spirit.
	35.	Pulse 72, more full and hard. Exhilaration.
	50.	Pulse not altered: a slight sensation of heaviness at the stomach.
10.	10.	Pulse 66, but yet full.
	35.	Pulse 66, but now becoming feeble.
	40.	Pulse 66; two grains of opium dissolved in a little water were now swallowed.
	50.	Pulse 68, and very full; greater degree of exhilaration.
	57.	Slight nausea with vertigo; pulse 68, and less full.
11.	5.	Pulse 66, and very weak; general languor, with violent pain at the stomach.
	10.	Pulse yet very weak: The severity of the pain encreases: It was a

Hours. Minutes.

30. Pulse not more than 68; yet considerably full: Face flushed; redness of the tunica adnata. Evident signs of intoxication.

55. Pulse 64 and beginning to be feeble: a degree of heaviness in the head.

11. — Pulse 64, more feeble. Slight vertigo: flushing of the face and redness of the eyes abated.

55. Vertigo remaining; an hour after, considerable sickness at the stomach came on. In the course of the day, it repeatedly returned, though relieved occasionally with spirits and water.

EXPERIMENT 42.

H. M.

10. 1. A gentleman took three grains of opium, upon an empty stomach, whilst lying in bed, pulse beat at this time 56 in a minute, and weak.

4. Pulse 58 and more strong.

6. Pulse 60 and encreased in strength.

8. Pulse 64.

13. Pulse 66; an additional grain was at that period taken.

Hours. Minutes.

little relieved by large draughts of lukewarm milk and water, but continued notwithstanding very severe, for more than three hours.

EXPERIMENT 41.

H. M.

8. 54. Mr. Mackenna, upon an empty stomach, took two grains of opium dissolved in a little water. Pulse 78.

9. — Pulse 80, and considerably more full.

22. Pulse 82, and continuing still full. A sense of heaviness and stupor in the head.

32. Pulse continues at 82, but rather more feeble.

54. Pulse fallen to 78, and diminished in strength. Sense of languor: Face flushed.

10. 5. Pulse sunk to 74, but yet somewhat full. Two grains more of opium were taken.

20. Pulse remains at 74: sense of languor abated; a little confusion of mind approaching to intoxication.

Hours. Minutes.

30. Pulse not more than 68; yet considerably full: Face flushed; redness of the tunica adnata. Evident signs of intoxication.

55. Pulse 64 and beginning to be feeble: a degree of heaviness in the head.

11. — Pulse 64, more feeble. Slight vertigo: flushing of the face and redness of the eyes abated.

55. Vertigo remaining; an hour after, considerable sickness at the stomach came on. In the course of the day, it repeatedly returned, though relieved occasionally with spirits and water.

EXPERIMENT 42.

H. M.

10. 1. A gentleman took three grains of opium, upon an empty stomach, whilst lying in bed, pulse beat at this time 56 in a minute, and weak.

4. Pulse 58 and more strong.

6. Pulse 60 and encreased in strength.

8. Pulse 64.

13. Pulse 66; an additional grain was at that period taken.

Hours.	Minutes.	
	15.	Pulse 68; encreased in strength. Sensation of heat in the forehead and eyes.
	20.	Pulse 64: breathing a little laborious, with a little confusion in the head, and drowsiness.
	25.	Pulse continues at 64.
	30.	Pulse 64.
10.	40.	Pulse 60, great tendency to sleep.
	45.	Pulse 60.
	50.	Pulse 60: respiration slow and somewhat laborious.
	55.	Pulse 59: gentle respiration. Intense thirst for the last ten minutes.
11	5.	Pulse 60: heat of the body encreased; violent perspiration in every part except the face.
	10.	Pulse 59: great tendency to sleep: eyes painful and bloodshot. Perspiration continues abundant. Pulse 59.
	15.	Pulse 56, and very feeble.
	20.	Pulse not more than 54 and feeble. After this he arose, was seized with nausea, which continued the greatest part of the day.

EXPERIMENT 43.

Dr. Clark offered himself as the subject for another experiment.

Hours.	Minutes.	
12.	49.	His pulse beat 64 before breakfast: he took two grains of opium dissolved in water.
12.	51.	Pulse remains at 64.
	55.	Pulse 72, and encreased in strength.
1.	—	Pulse 72; a little confusion in the head.
	5.	Pulse 74.
	9.	Pulse continues 74, strong and full.
	11.	Two grains more were taken. Sense of pain in the head.
	15.	Pulse 75 to 76: drowsiness.
	20.	Pulse 77: drowsiness and stupor.
	25.	74, somewhat more weak: respiration short and laborious.
	30.	Pulse 76; inclination to sleep.
	35.	Pulse 76, but not so strong as a quarter of an hour ago.
	40.	Pulse 73; he is now soundly asleep: Heat of the skin encreased.
	45.	Pulse 73, and becoming weaker.
	50.	Pulse 73; sleeps sound: breathes easy.

Hours.	Minutes.	
	56.	Pulse 69; skin hot and dry.
2.	—	Pulse 68; much weaker.
	5.	Pulse 67.
	10.	Pulse 67.
	15.	Pulse 63, and weak.
	20.	Pulse 62, weak and feeble.
	25.	Pulse 62.
	30.	Pulse still 62: He did not fall lower than this, although repeatedly measured after this period.

EXPERIMENT 44.

Dr. Clark subjected himself a second time.

H.	M.	
12.	5.	Pulse 65: He took one grain of opium upon an empty stomach.
	10.	Pulse not much altered.
	15.	Pulse 70, and encreased in strength.
	25.	Pulse 76, and considerably more strong.
	30.	Pulse 76; pain of the head. Another grain was taken.
	35.	Pulse 75.
	40.	Pulse 76.
	45.	Pulse 78; giddiness and confusion.
	50.	Pulse 76.
	55.	Pulses 76.

Hours.	Minutes.	
1.	—	Pulse 75; another grain was given.
	5.	Pulse 75.
	10.	Pulse 75.
	15.	Pulse still 75.
	20.	Pulse 72.
	25.	Pulse 72: Confusion, and a little giddiness.
	30.	Pulse 72, and somewhat weaker.—A fourth grain was taken.
	35.	Pulse 72.
	40.	Pulse 72: a degree of somnolency.
	45.	Pulse 73.
	50.	Pulse 74.
2.	—	Pulse 72, and becoming more feeble.
	10.	Pulse 69, and evidently more weak. Sleeps.
	20.	Pulse 68.
	30.	Pulse 64, very feeble.
	40.	Pulse 58, and very irregular; beats sometimes not more than three times in five seconds, and sometimes it beat eight in five seconds.
	45.	Waked affrighted: This agitation quickened the pulse: it beat at
	47.	64.
	50.	Beat 62; no further observation was made upon it.

In these experiments, in which the several substances were taken into the human stomach, a perfect analogy on the following points is established.

1st. It is concluded, that an encreased action of the heart and arteries and energy of the brain resulted from the action of opium, æther, spirits of wine, and spiritus volatilis aromaticus taken into the stomach. Vide Exp. 38, 39, 40 & 41.

2d. That in the course of an hour or thereabouts, after the administration of the above several substances, the actions which they had induced were diminished, and a state of debility succeeded. Vide *ut supra.*

3d. That an equal quantity of the same substances which had once excited action in the system, was inadequate on a second exhibition to raise the action of the system to the same point again. Vide *ut supra*, & 43, 44.

The remarks which were made upon Dr. Bard's experiment, are, in consequence of the phœnomena presented by the last experiment upon the human pulse, shewn to have been very just, for it is there evident that the pulse in the space of one hour from the exhibition of opium, had sunk down either to the natural standard or below, after having been encreased more than ten pulsations in a minute. At this

period my observations correspond with those of Dr. Bard's, but lead to an opposite conclusion; for it is evident, that he only noticed the state of the pulse which was presented after the cessation of the primary effect of opium, and not the condition which existed during the action.

I am now enabled to account for the defect of appearance of encreased action upon the application of opium to the hearts and stomachs of frogs. In all bodies endued with life, a certain property is present by which they are enabled to receive the impression of powers applied.

The effect which results from the application of powers so applied to this property is called action: confined to the muscular fibre, this property has been denominated irritability: in the nerves it is called sensibility. The late ingenious and philosophic Brown, distinguished this property by the term excitability, expressing a general principle in the body of receiving impressions, but without referring it either to the nerves or muscular fibre in particular.

As this term appears to be very comprehensive, we shall crave the liberty to employ it in this place. Supposing then, all powers applied, act upon this property, it is proved by Experiments 38, 39, 40 & 41, that in conse-

quence of the action produced, this property becomes diminished, so that to produce an equal effect a second time, the power acting is required to be applied in a greater degree; but it is also proved by Experiments 16, 17, 18, & 19, that the same power, which in a diminished quantity, produces action and exhausts a portion of this property, when applied in a large quantity, altogether exhausts this property, without producing any apparent encrease of action, so that the application of no powers can again excite action; and it is also proved by Experiments 31, 32, 33, 34, & 36, that the more abundant this property is, the more speedy is the action which results from the application of the powers, and more speedy is the cessation of that action; now admitting this, it will follow, that the power applied may be so intense, and the excitability so abundant, that the action produced may not continue for the duration of a minute; supposing further these two, viz. the power acting and the property acted upon, to be in a still greater disproportion to each other, the action which ensues may be instantaneous, or even so quick as to elude our perceptions. Thus a slight shock of electricity, occasions muscular contractions, and diminishes the excitability of the part where the action took place: But a

shock may be given so strong, as to exhaust the excitability *in toto*, without the least degree of action being evidenced. The diminution of action, and the exhaustion of this property, which were evident upon the application of opium to the hearts of frogs, vide Exp. 1st, 2d & 3d, furnish therefore no argument in favour of its sedative effects; for it is clear that the same condition is also the consequence of the application of powerful stimuli, vide Exp. 10th, 11th, 12th & 13th, and is to be explained in the above manner. The condition in which the muscular fibre is left in these instances, so far therefore from weakening the facts alledged in favour of the stimulant action of opium, is rendered a very powerful proof in support of it. But it must not be omitted here, to give proper weight to the experiment in which the action of the heart of the frog was encreased upon the application of a very small quantity of opium, as the above explanation makes it appear in a stronger light. For if a powerful stimulus exhausts excitability without producing visible encrease of action, in consequence of its stimulant effect, and if the operation of opium is to be attributed to the same cause, this stimulus applied in a diminished dose, and in a proportion suitable to the excitability of the part, must

of course, produce evident action: and this did appear to be the effect of opium in the experiment above quoted, viz. Exp. 4th.

These deductions being admitted, in order to have a correct idea of the effect of a stimulant operation, we should define a stimulus to be "a power which encreases the action of "the heart and arteries, the energy of the "brain, and diminishes or exhausts the ex- "citability of the system."

CHAP. II.

OUR attention is next called to examine what is the effect of powers termed sedative, when applied to the animal body; for by this term is understood the operation of a power presenting phœnomena directly the reverse of those exhibited under the operation of stimulants. The condition induced by these means we shall compare with the effects resulting from the exhibition of opium, in order that the analogy we have attempted to establish, may be rendered more complete by the aid of contrast.

Amongst the various sedative powers enumerated by authors, there is none concerning

which there has been less difference of opinion, than respecting the effect of cold. This power, although considered by some as stimulant when applied to the animal body at a degree somewhat inferior to its own temperature, has, however, been esteemed sedative by all, when applied in an intense degree. It is in this degree that we shall examine its effects.

EXPERIMENT 45.

A middle-aged rabbit, whose pulse beat 252 in a minute was put into a tin vessel placed in a Frigorific mixture.

Hours.	Minutes.	Ther.	
11.	—	0.	Animal struggles to escape.
	10.		Animal's pulse less distinct, but beats 264 in a minute.
	20.	10.	Pulse much weaker, but yet 264 in a minute. The thermometer rose considerably when the animal was first put in, but the temperature could not be taken on account of the struggles of the animal.

Hours.	Minutes.	Ther.	
	30.		Pulse is now more slow and more feeble, not more than 240. Animal trembles very much and is less active.
	40.	10.	Pulse not more than 216.
11.	—	—	Pulse very feeble, only 192.
	30.	12.	Pulse considerably more feeble; can scarce be counted, yet not more than 180. Animal trembles and breathes very laboriously. In this state the animal was left until morning: the frigorific mixture had dissolved during the night, and the thermometer had rose to 50. The pulse of the animal was feeble, but beat 240 in a minute.

EXPERIMENT 46.

A full-grown frog, whose heart beat 62 in a minute at

H.	M.	
10.	—	Was put into a tin vessel of the temperature of 8°.
	2.	Frog removed. Heart much more feeble; beats only 26 in a minute. Animal put in again.

Hours. Minutes.

6. Animal removed: his heart so feeble as not to be distinguished to beat through the integuments.

11. — It was put into the cold again.

11. Animal removed: the skin under the belly and the thigh was beginning to freeze, and it had no power of motion. The thorax was opened, the heart presented itself, beating feebly only six times in a minute; after being exposed to the air for a few minutes, the animal recovered a slight degree of motion, and the heart encreased to eighteen pulsations in a minute. The animal was dead about an hour after.

From these experiments, I am enabled to draw the following conclusions.

1st. That cold diminishes the actions of the body.

2d. That this effect is shewn by the diminished temperature and diminished action of the heart.

It is deserving to be remarked, that when the rabbit was put into the cold, its pulse was accelerated, but rendered more feeble; but

that after it had been exposed some time to the cold, it became both slow and feeble.

As we found that the effects of stimulants were greater upon young than adult animals, proven by conclusions page 62.

We proceeded to examine the effect of the sedative of cold upon animals of different ages.

SECTION II.

What are the Effects of Cold upon young and adult Animals?

EXPERIMENT (a.)

Hours.	Minutes.		Temp.
12.	—	Adult rabbit put into a tin vessel, temperature heart beating 264 in a minute.	15°.
—	30.	Heart beats 276 in a minute, but very feeble. Animal makes great struggles to escape.	17.
1	—	Animal breathes laboriously, Pulse 252: A fresh mixture of snow and salt was put into the outer vessel.	17.
	10.	Pulse very feeble, and slow; cannot be numbered.	5.

Hours.	Minutes.		Temp.
	30.	Animal breathes very laboriously: The thermometer placed between its thighs, rose to 84.	4°.
2.	—	Animal coils itself into a round form; appears very uneasy, frequently licks its feet.	2.
	30.	One of the fore feet rigid at the extremities; the pulse very slow and feeble.	2.
3.	—	The other foot rigid. The extremities of both ears rigid: the heart can now scarce be distinguished to beat through the thorax.	2.
	30.	All the feet rigid: the animal scarce able to support itself.	
4.	—	Animal is dead. It was removed.	

The thorax was opened, the heart contracted feebly, not more than 29 times in a minute. The heart was opened and a thermometer introduced, it rose only to 58.

EXPERIMENT (b.)

Hours.	Minutes.		Temp.
12.	20.	Young rabbit put into a tin vessel, heart beating 252 in a minute. Violent struggles.	16°.
	30.	Animal very uneasy and cries frequently; pulse 276, and feeble.	18.
		Fresh supply of snow and salt put in	
1.	20.	Animal coils itself into a round form. Temperature when the thermometer is put betwixt the thighs 86: in the vessel,	4.
		Pulse not more than 252, and more feeble.	
	50.	Thermometer betwixt the thighs 80. Pulse so weak as not to be counted to more than 240.	
2.	20.	Animal breathes laboriously, but makes yet occasional struggles to escape.	0.
	50.	Both the fore feet beginning to be rigid.	0.

Hours.	Minutes.		Temp.
3.	20.	Animal moves about the vessel; pulse very weak, but cannot be counted.	0°.
	50.	Animal's ears rigid.	
4.	20.	Animal without motion, yet breathes very distinct. Thermometer betwixt the thighs and the body, 76.	0.
5.	—	Animal still breathes, but appears almost dead: Thermometer in the pelvis 45.	
	40.	The animal is dead. The thorax was opened; the heart moved feebly not more than 25 in a minute. Thermometer introduced into the heart; rose to 52.	

In this experiment it is evident, that a young animal can support an intense degree of cold for a longer time than a full grown animal; also, that the actions of the system can go on under a much inferior temperature. This experiment confirms some of those made by the order of the Royal Medical Society of Edinburgh, 1785, with the view of ascertaining some effects of cold.

EXPERIMENT (c.)

An experiment directly apposite to that just related, we take the liberty to quote.

" A full grown rabbit, the hairs of the skin occasionally wetted, died after two hours and forty-one minutes, when exposed to a degree of cold which varied from 15 to 10°."

" The blood let out from the heart of another adult animal killed by cold, raised the thermometer to 58°."

" A young rabbit compared with the first and wet in like manner, sustained life more than five hours, in a degree of cold, which varied from 15 to 2°."

" The blood of another young rabbit killed by cold, when the heart was punctured, raised the thermometer, only to 48°."

From these last related experiments it appears probable, that the action of the heart of a young animal whose excitability is more abundant than that of an adult animal, can go on for some time in a temperature which will even destroy the life of an adult animal.

We next proceeded to examine the effects of cold upon animals whose excitability is more abundant, than in young rabbits.

EXPERIMENT 47.

Four full grown frogs were placed in a tin vessel at the temperature of 8 degrees: when the animals were introduced, the thermometer rose to 19; the frogs made very violent struggles and appeared very uneasy. After eight minutes they were without motion: thermometer at 7 degrees: after ten minutes the skin of the belly of each was rigid, and after 15 minutes all the under part of the body and the extremities were frozen.

The skin upon the back of the bodies was yet soft. They were removed after sixteen minutes.

One animal was placed in the open air, in a temperature of 54; a second was placed in the window of a room where the temperature was more than 60; a third was placed at a distance from the fire, where the temperature was 80; the fourth was placed still nearer, in a temperature betwixt 90 and 100.—After about the space of three minutes, the two animals which were placed in the warmer temperature, became soft and exhibited a feeble motion; they were then removed. The other two were not yet able to move. After five minutes a feeble motion was observable in the

inferior extremities, and after 10 minutes they were able to draw them upwards. All the four were placed in a temperature of 60: after an hour the two frogs, which had been softened in a warm temperature were dead: the other two were yet feeble, but were able to draw their legs up to the body. After three hours the animal which had been exposed to the open air was more vigorous than the other. Both the frogs were then put into cold water at 56 degrees; they appeared for some time to have very little use of the extremities, but were buoyed up near the surface; after about half an hour, both the animals had gained sufficient strength to swim feebly about the water. One was now removed and placed upon a dry plate: after twelve hours, the animal which was left in the water, was dead, but the other animal upon a dry plate was yet feebly alive.

EXPERIMENT 48.

Another frog was placed in a temperature of 0°: the thermometer rose immediately 8 degrees; after ten minutes thermometer at 0°. The animal remained five minutes longer; when taken out, it was universally rigid; it was placed in the open air, in a temperature of

54, where it recovered a little feeble motion of its hind extremities, but was found dead after three hours.

EXPERIMENT 49

Amongst the very ingenious experiments of Mr. John Hunter, many curious facts are met with demonstrating, that animals whose excitability is great, can exist in a temperature below the freezing point: as they tend to the same point as the above we shall quote some of them.

"The temperature of a viper is 68 degrees. "It was placed in the temperature of 10 "degrees: after ten minutes, its temperature "was reduced to 37: after ten minutes more "it was 35: after 30 minutes, it was at 31. "The temperature did not descend lower; the "tail was beginning to freeze!"

"The temperature in the stomach of a frog "was 44; the animal was put into a degree "of cold, when the temperature in the sto "mach fell to 31; the animal appeared "almost dead, but recovered soon after being "taken out. Beyond this point, the heart "could not be lessened without destroying "the animal."

" The thermometer was 69 in the stomach " of an eel. When exposed to a great degree " of cold, the thermometer fell to 31: The " animal was removed and recovered."

" The thermometer was 44 in a snail: In " the cold vessel it was reduced to 31: after " some time the thermometer rose to 32; the " animal froze and died.".

From these we conclude that the more abundant is the excitability, the greater is the reduction of the temperature which the animal can bear *without having the actions of life destroyed.*

It was observed, conclusion the 3d, page 47th, that the capacity of an animal's body to receive impressions was diminished by the application of stimulants. We next proceeded to enquire what would be the effect of the application of a sedative power.

EXPERIMENT 50.

A middle-sized rabbit's pulse beating 252, was put into a vessel whose temperature was 30°.

Hours. Minutes.

8. — Animal appears uneasy from the cold.

10. Pulse 264, but diminished in force.

Minutes. Minutes.

20. Pulse 276; temperature then raised to 35.

30. Pulse 264, and more feeble. Temperature 30.

40. Pulse scarce 252 and very feeble. The animal was removed: three tea-spoonfuls of the spirits of wine were thrown down the œsophagus into the stomach: N. B. The œsophagus was opened before the animal was put into the cold vessel.

50. The pulse 276, and greatly encreased in strength: the animal appeared drunk; can scarcely support itself.

55. The animal lay prostrate; appears to have lost the use of its limbs: pulse more quick and strong, 288.

9. — Pulse 276, but yet strong and full. The animal makes a stertorous noise as if he was asleep: no motion of the body.

10. Pulse 276; beginning to be more feeble.

20. Animal appears to be in a state of insensibility, or rather a profound

Hours. Minutes.

sleep, but the eyes are open and have lost their sensibility: pulse so feeble that it can scarce be numbered; it may be about 240.

30. Pulse cannot be numbered. When the animal is struck he makes feeble motions in the extremities.

10. — The animal lies in the same state: loud stertor and laborious respiration.

12. — The animal appeared much the same.

In the morning it was found dead, being left in the above state at bed-time.

EXPERIMENT 51.

At the time when the spirits of wine were thrown into the stomach of the last rabbit, the same quantity was thrown into the stomach of another, equal in size and age, but which had not been exposed to cold; after ten minutes the animal was able to run about; after fifteen minutes its pulse beat 276. The animal was then enfeebled and could not support itself: after twenty minutes, it was prostrate like the other. His pulse beat 288; after 25 minutes

pulse beat 300: after 30, pulse 288 and beginning to be more feeble, a stertorous noise resembling that in the other animal: after 40, pulse 264. The animal lay in a seemingly insensible state, the eyes were open but had lost much of their sensibility: at 11½ pulse very feeble but was counted to 252. In the morning the animal was alive, had recovered so much as to be able to run about, but was feeble and appeared to labour under great insensibility: the respiration was easy and its pulse beat 240: after some hours he eat and perfectly recovered.

EXPERIMENT 52.

Four large frogs were placed in a temperature of melting ice, they seemed uneasy in the situation, and attempted to escape. After being exposed ten minutes, one was removed; ten drops of the spirits of wine were thrown down the œsophagus. After ten minutes more, a second was withdrawn: ten drops more were thrown down the œsophagus: after 30 minutes a third was removed, ten drops more was thrown down into the stomach: after forty minutes, the fourth; ten drops were likewise thrown into the stomach of this: at this time the frog which had first been removed, was

able to move about, but the second was so feeble as not to move. They all died except the first and in the following succession. The last animal removed from the cold died in less than two hours; the animal removed the third lived near three hours: the animal removed the second lived longer than five hours. The animal removed the first, after one hour was so feeble as to be incapable of motion; after five hours, he had recovered in some degree, and was then put into cold water; the day following he was weak, but at length entirely recovered.

EXPERIMENT 53.

Ten drops were thrown into the stomach of a frog of equal size as the other four, he was made weak by it for several hours, but after 12 hours had elapsed had nearly recovered all his former strength.

From these experiments, I conclude that the capacity of receiving the action of stimuli, is encreased by the effect produced from the application of the sedative cold.

The particularization of the effects of this sedative power furnishes us with the following conclusions.

1st. The sedative effect of cold diminishes all the actions of the body.

2d. It diminishes the temperature by experiment.

3d. It diminishes the action of the heart and arteries in the first instance, by rendering them quick and feeble; in the second by rendering them slow and feeble.

4th. That its effects are experienced more readily by adult than young animals. Exp. a. b. c. Section 2d. The three last conclusions proven by them.

5th. That animals of an inferior temperature whose excitability is abundant, can subsist under lower degrees of this power, than warm-blooded animals, or those whose excitability is not so abundant. Exp. 47, 48, 49.

6th. That animals exposed to its effects have their capacity to receive the action of stimulants encreased. Exp. 50.

From these conclusions, it appears proper to express a sedative in the following manner.

A power which diminishes the action of the heart and arteries, the energy of the brain, and encreases the excitability of the system.

By comparing these conclusions with those drawn at page 62, it will be found that the effects produced by stimulant powers and by the sedative one of cold, are directly the reverse

of each other. As by those conclusions it was proved that opium produced an effect upon the body similar to stimulants, and as it is now proved by conclusions 4th, 5th & 6th, p. 95, that the sedative effect of cold exhibits appearnces and induces a condition of the body opposite to those which were observed under the operation of stimulants, that as the analogy held good betwixt stimulants and opium in every instance where we subjected them to experiment; and that in those instances, where we have compared the effect of sedatives as exhibited likewise by experiment, the analogy has altogether failed; it is to be inferred from thence, that the effect of opium is inversely as the effect of sedatives, and directly as the effect of stimulants.

To trace the analogy somewhat further, it appears by experiment 47, 48 & 49, as has already been observed, that frogs and other animals whose excitability is abundant, can sustain life in a temperature beneath the freezing point, and also by experiment a. b. c. section 2d.—That young animals whose excitability is more abundant than adult ones, can support life under greater degrees of cold than adult animals; we further conclude, that the effect of sedatives is directly at the excitement, and inversely as the excitability. Further, as it is

proved that frogs are more easily affected by stimulants than those animals, whose excitability is not so abundant, and by Experiment 31, 32, 33 & 34, that young animals are sooner affected by stimuli than adult ones: it is further to be concluded, that the effect of stimulants is directly as the excitability, and inversely as the excitement. Also, it is proved by Experiment 21, 22, 23 & 24, that opium affects frogs more speedily than warm-blooded animals; and by Experiment 35 & 36, young animals of warm blood more readily than adult animals of warm blood, that the effect of opium likewise is directly as the excitability and inversely as the excitement.

As the comparison therefore has held good in all those instances we have related, betwixt opium and stimulants, and in the production of those effects, which are the usual and principal effects of the action of stimulants upon the human body, we are led to the final conclusion, that the appearances, exhibited by the animal body under the influence of opium, are directly analagous to those exhibited under the action of æther and spirits of wine and volatile alkali; that as these powers are stimulant, so in like manner, and depending upon equal proofs, is opium stimulant.

ON THE MACHINERY OF THE ANCIENT EPIC POEM.

BY THE REV. GEORGE WALKER, F. R. S.

Read Dec 2, 1800.

IF prejudice apart from sound judgment decide in matters of religion and philosophy, where sound judgment alone ought to be sovereign, it is not to be wondered, if her capricious authority be sometimes found to usurp in the less regulated provinces of taste and criticism, and her influence be found equally injurious to truth in each. It has been said, that, when system begins, genius ends. This, like many other bold maxims, whose very boldness conciliates belief, must be subject to numerous exceptions; for men of respectable talents are found among the friends and patrons of system; particular systems owe their very birth to eminent genius, and the system of the universe is referred to genius of the sublimest form. The maxim therefore is not universally true, for genius may be the author of system, and genius may be laudably exercised in conformity to system. But still there is a considerable degree of truth in the maxim; for systems, however fabricated, and to other

parents than a penetrating view of truth and nature are many systems indebted for their existence, are in the habit of requiring an implicit obedience; they preoccupy the early mind, before it is fitted for individual exertion; their rules become a law, without enquiry into the truth and reason of the law; intellect submits to the law; her native freedom is fettered; and genius, naturally capable of originality and specific character, is stifled by this dominant prejudice, and creeps along through ages in the dull walk of conformity to rules, where nature perhaps would allow of a generous latitude.—More than two thousand years have passed since the days of Aristotle, but the system of Aristotle is still an imperial law, and is an interdict on genius in the walk of Epic Poetry; for believing from a tame submission to authority, that every thing in the epic of Homer, from whom the system of Aristotle is altogether derived, is to be admired as the standard of excellence, we can neither bear with an epic production, which is original in its manner, and disdains the trammels of Homer and Aristotle; nor can we bear with an imitation, for this is frigid and tasteless to us, because we have acquired another taste, which we can sacrifice only to Homer, or to Virgil. These a venerable antiquity has equally

excepted from the decision of modern taste, and, I might add, of a taste more chaste, correct and elevated. The Poetics and other critical works of Aristotle, founded upon the models of an old and almost barbarous antiquity, have, indeed, bound genius in chains, and to that talent of man, which of all others delights in freedom and an expansive range, and in her favoured field of poetry, has prescribed a hackneyed path, where nature in her richest and most luxuriant dress is not to be found. Hence the prejudice, that the poets of Greece and Rome, but particularly of Greece, are superior in every excellence to those of later days. I hesitate not to deny the fact, but if it were as by the general voice is supposed, the very prepossession is sufficient to produce the effect. They are, forsooth, the only standards of true taste and elegance; excellencies have been discovered in them, which in all probability, their authors, with all the vanity of an author, had no idea of, and which the modern literati neither see nor feel, but only suppose that they see and feel; and all praise for originality of thought, and fertility of invention, has been lavished on them alone.

This partiality, whether just or not, is without any difficulty traced to its origin. The writings of these poets are almost our

only literary companions in our younger days. It is the business of our instructors, to enable us to understand them, and their beauties are minutely and almost officiously pointed out to us. At an age, in which we make little resistance to any impression, and yet are remarkably susceptible of impressions, and remarkably retentive of impressions, we are taught to regard them as the very models of the beautiful and sublime in thought and expression; the graces of our own poets are either wholly unknown, or but transiently and partially introduced to us; and Milton and Shakespeare are but second names with us. It is also unfavourable to a just estimate of merit, that these impressions, are made at a period, when the beauties of poetry have the easiest and most agreeable access to us. The pleasures, which enlivened that happy period, are hallowed to our imagination with an enthusiasm, which for ever endears to us the objects that excited them, but which no similar objects will ever awaken again with the same kindly glow. Add to this, that those authors, whose taste in this walk of literature is commonly appealed to as decisive, concur with the impressions that we are in the habit of receiving, our prepossession is strengthened by such respectable testimony, our judgment is flattered by such concurrence,

and a very questionable prejudice takes possession of our very understanding. Allowing to the Iliad and Odyssey all that a pure taste and judgment can relish and can approve, there are innumerable passages, which the same taste and judgment cannot enter into, which it may candidly pardon and excuse, but cannot sanction as absolutely proper, beautiful and sublime.—But this would be of little moment, if it acted not with a malignant influence on future genius. That gift, which nature, not art or rule, confers, is not permitted freely to exert itself; fancy is controuled in the free and vigorous exertion of its powers. Melmoth has justly obscrved, that this fondness for the ancients has probably occasioned to us the loss of many excellent originals. For though, continues he, they may be proper and safe guides to those, who have not the greatness of mind to strike out new paths; yet, while it is thought a sufficient praise to be their followers, genius is checked in her flights, and many a fair track lies undiscovered in the boundless regions of imagination. Thus had Virgil trusted more to his native strength, Rome might perhaps have seen an original Epic Poem in her own language. But Homer was considered even by this admirable poet as the sacred object of the first veneration; and he seemed to think it the

noblest triumph of genius to be adorned with the spoils of this illustrious Grecian.

It is not, however, my intention, to discuss the general question of the superiority of the ancient poetry above that of the modern; but only, as the genus comprehends the species, to introduce the particular discussion, which is the professed subject of this essay by some mention of, and some opinion on the general question. The mythology of the ancients, which was the popular belief of their day, and on which the machinery of their epic poem is founded, is supposed to derive to it its special advantage; as this advantage is not allowed to the modern, because with a change of the popular creed no sympathy can be extended to him in the use of such fabulous machinery. I mean therefore to shew, that in its own nature, and with every allowance of belief, it is a miserable machinery; puerile; with no consistency and unity of character; beneath human nature; and, having no dignity in itself, incapable of conferring a dignity on the poem, which uses it and uses it as a principal substratum of the poem. I might, without any circumlocution, appeal immediately to the sense of every one present, and expect a general verdict in my favour. But, since the time of the ancients the question has assumed a new

form from the ingenuity of some of the modern devotees to the ancient poetry; and in the celestial actors, of whom the Epopœa and the Drama of the ancients makes such important use, we are not to contemplate real personages, but allegorical representations, in which allegorical interpretation every thing debased and low is excluded, and, adopting this idea, we are directed to contemplate a dignity in those actors, which as persons they are totally destitute of.

This allegorising of the heathen pantheon owed its origin to the impotent attempt of some pagan philosophers, of the later Platonic School, with a view to rescue paganism from the reproach of its rude and gross theology, which in its popular acceptation could not look christianity in the face. Christian philosophers have taken the lesson from them, and the fine-spun theory which the former invented from a zeal for the sinking cause of the heathen religion, the latter adopted from an equal zeal for the honour of heathen poetry. What in the name of religion the better sense of mankind turned from with disgust, it was feared that their better taste would be equally disgusted with in the representations of the poets of Greece and Rome. The gods, as gods of antiquity, might fall into contempt and oblivion,

but the celestial machinery of the ancients must be preserved at any rate; and, as no solid base of support could be found, an airy and visionary base must suffice and poetical taste must be taught to worship what moral taste loathed.

It will be proper therefore, 1st. To examine on what foundations this allegorical interpretation of the pagan deities rests; whether it can be maintained; whether the allegory be supported with any thing of that consistency and unity, which the supposition of it requires; whether it be credible, that the poets of Greece and Rome, by the exhibition of their celestial machinery, designed real personages such as the popular faith received them, or merely an allegorical representation of certain dignified virtues. If, under this examination, the supposed allegory be found to be an unsubstantial fabric, the whole building, that is raised upon it, falls to the ground, and the machinery in its plain and literal acceptation must answer for itself and must be tried by the rules of universal good sense and taste, and by these rules it must be decided, whether any poem can derive a dignity from the use of it.

But, before we can bring to the test of credibility this allegorical metamorphosis of the heathen deities, we must know precisely what

it means, and no better guide to this knowledge presents himself than the celebrated Bossu, the great admirer and champion of the ancients. His definition of epic poetry is, that it is a discourse artfully invented to form the manners by instructions, which are disguised under the allegory of some one important action, related in verse, in a probable, diverting and surprising manner. Agreeably to this definition (in which the critics have thought proper generally to acquiesce) he defends the machinery of the ancient epic poem against those, whom its apparent absurdity offends, by saying, that, with a view of conveying instruction by one great moral, which formed the ground-work of their poem, which the whole action served to illustrate, and which was conveyed by allegory, they meant that all their gods and goddesses should be considered as allegorical, or as representative of some mental, or physical quality or defect, to which all their actions are supposed to relate, and with a reference to which they are all to be considered.

You will please not to smile at this fanciful statement of the ancient epic, because it would disturb the sober view, that we are to take of it. There are, in this statement, two distinct objects offered to consideration,

1st, whether the ancients ever did intend to make their poem to conduce to one great moral; and 2dly, whether they designed to support that moral by a continued allegory, and that for this purpose all their celestial machinery, as composed of mere ideal personages, was introduced.

To admit the first, viz. that in the epic poems of the ancients one great moral is intended and supported through the whole, would not materially weaken the argument of my essay. But this position is open to strong objections. It may be said, that the end of poetry is not so much to serve as a vehicle of moral sentiment, as to please by addressing itself to the imagination and passions, in the conduct of which many morals may be inculcated, and many of equal worth and dignity. With this idea the epics of Homer and Virgil well accord, much better, I think, than with the notion of one single leading moral through each of their poems. It would not be difficult to assign to each of these poems a variety of morals, each claiming precedency with such a shew of probability, as to leave it doubtful on which side the balance inclined. Poetry must instruct, if it be any tolerable delineation of human character and passions, for every character to a reflecting mind is either a positive,

or a negative lesson. It is said, that the great moral of the Iliad is, to teach the Greeks the advantages of union. The Greeks, in the time of Homer, had no formidable common enemy, as in a later period, when the Persian power threatened the general ruin of Greece, and, therefore, what circumstance suggested to Homer the importance of this moral, so as to found his poem upon it, is rather difficult to say. The critics, however, have pronounced this to be the moral, to which the whole Iliad is adapted, and such an implicit faith is rendered to their sentence, that it would be considered as a degree of scepticism to dispute it. It must be acknowledged, that this moral is fairly to be collected from the Iliad, but whether Homer designed it, or no, and fashioned his poem to this purpose, is very uncertain.—It is probable that he took the tradition of the siege of Troy and the characters of its principal actors, as they were committed to him; and formed therefrom a popular tale, enriched with the embellishments of poetry. It is no wonder, that discord entered into the history and that Homer exhibited it in his poem, because he found it in the history; as discord could hardly fail to be the issue of a confederacy, formed by rude, undisciplined and independent chieftains. May it not with equal probability

be supposed, that impiety and irreverence to the gods in the person of Agamemnon, the general of the whole confederate army, when he rejected the modest prayer of Chryses, the priest of Apollo, and treated him with indignity and insult, was the great crime, which the poet meant to reprobate, and in the sequel of the poem to exhibit the long train of calamities, which were the punishment of this crime? From this impiety of Agamemnon sprang the discord of the chiefs and all the evils, which followed. To a people, composed of a multitude of independent states, piety to the gods might be supposed to be a more important moral than concord. Homer, indeed, in the opening of his poem assigns the quarrel between Agamemnon and Achilles, as the proximate source of the μυρια αλγεα Αχαιοις, which constitute the history of his poem; but the irreverence of Agamemnon to Apollo, in the person of his priest, to which he immediately passes, is the primary cause. He describes the indignation of Achilles, as the consequence of Agamemnon's irreverent conduct; and the first calamity of the Greeks is the infliction of the offended god. If the probability of this, as a principal moral, be admitted, it will justify a farther inference of moment in this essay, that Homer had no idea of mere allego-

rical personages in his deities, that he received them as objects of serious belief, and considered a reverence to them as of high importance to the public welfare.

It is an essential part of this chimerical theory, that these allegorical personages, the deities, are introduced into the poem in order to give a dignity to the moral, and therefore it is required, that their whole character and action be conformed to the moral. Now, if the evils, which spring out of discord, and the blessings, attendant upon union, be the great moral, on which the whole plan of the Iliad is constructed, it must be confessed, that the character, which Homer has assigned to his allegorical personages, is very ill adapted to this moral, and very little calculated to give efficacy and dignity to it. Inasmuch as they are designed to be exhibited as beings of a superior order, and objects at least of popular reverence, they ought to be clothed with some dignity of character, and appear to be exempt from the follies and passions, which originate the quarrels and dissensions of men. Every thing contrary to this is the character of Homer's celestial machinery. They appear with no dignity of character, with no abstraction from the lowest follies, from the wildest passions of men; their superadded agency presents no picture of

union; inculcates no moral of union; they are partizans in the private and public quarrels of the Greeks; they are incendiaries, not appeasers; and this not as a mode of inflicting a divine punishment on crime, which, if Homer had so exhibited them, would, indeed, have presented a dignified moral and given a decent credibility to the reveries of his too passionate admirers; but without the intimation of their acting from one moral motive, of their being the ministers, or even the instruments of justice, they range themselves on the part of the Greeks or Trojans, or enlist under the leaders of the factions; inflame their animosities and aid their vengeance; and it is severe suffering, not any thing in the character and conduct of the gods, that teaches at all to the Greeks, or to the Trojans, one moral lesson. In fine, there is no adaptation in any view, and as the creation of the poet, of the celestial machinery to any one moral whatever, and least of all to the moral of union. The supernatural agents of the Iliad were assuredly neither in whole, nor in part, the creation of Homer; as he took his men, he took his gods, just as he found them in the page of history, or from the mouth of tradition; he does not appear to add to, or detract from their historic character as he received it, nor is there any thing in the most

dispassionate view of the Iliad, which will support the notion, that he had any controling moral in the eye of his mind, according to which he constructed his poem, or that he fashioned and shaped his men and gods to fit them to this moral. On the subject of one leading moral of the Iliad, to which the whole poem is supposed to be conformed, I shall add this farther observation, that besides piety to the Gods, which I have already noticed, this other moral, whether designed by Homer or no, is very strongly impressed on every feature of the poem, and for which I have no less authority than that of Horace, an authority of high respect in the court of criticism,

Quicquid delirant reges, plectuntur Achivi.

Which may be familiarly translated,

When kings play the fool, the people pay the piper.

It requires also no strain of ingenuity to deduce this farther moral, as equally entering into the whole plan, that all human events are governed by the gods, as this moral is not presented by the action, but by the sentiments to this purpose, which lie scattered through the whole poem.

Upon the whole, I see no sufficient reason to conclude, that any one preconceived moral, as the ground-work of his poem, which was to be illustrated by the whole and to which his allegorical creation was to conform, had possession of Homer's mind. The history, as Homer received it, must suggest many moral reflections to him; just as in the conduct of the poem the same moral reflections will present themselves to the mind of the reader; but I can see no unity of moral pervading the whole poem and giving law to the whole conduct of it.

The case may be different with respect to Virgil. He followed Aristotle, longo quidem intervallo, as Homer much preceded him.—Aristotle thought he saw an unity of moral in the plan of Homer's poem, and he considered it as one of the three necessary unities, which must enter into the composition of every heroic, or epic poem. Virgil, therefore, had a supposed precedent and law presented to him, and, influenced thereby, he might design one leading moral as the prominent lesson of his poem. It is supposed, that piety to the gods and resignation to the divine will are this predominant moral. Piety and resignation to the gods are certainly a principal trait in the character of his hero Æneas. He designed his

hero through many difficulties and conflicts finally to triumph, and, therefore, it might be expected, that his poem would be so managed as to derive the final triumph of his hero from his ascendant virtue, and to illustrate the excellence of piety by a striking exhibition of its rewards. But the conduct of the poem presents no such view, and the piety of Æneas appears to have but little influence on his fortunes. Not all his piety can soften the ira sæva Junonis; nor is the interposition of any god, not even of the supreme Jove, in his favour, ever, that I remember, referred to his piety. The maternal piety of Venus, and not the resigned piety of Æneas to the gods in general, appears to be his most effectual friend. Virgil clothes his hero with the virtue of piety, but, having done this, the conduct and the machinery of the poem are but little accommodated thereto. Virgil, I think, was of the Stoic sect, and with submission to my lords, the critics, I would offer a conjecture, that the Stoic maxim is not foreign to the spirit and conduct of the Æneid, viz. that a consistency of character and steady pursuit of one great object will be attended with an honourable issue, and triumph over the opposition both of gods and men. If there were but a moral in it, but unfortunately it is of

those stubborn materials as to defy moral, I should mention one leading object of the Æneid with more assurance; that he intended to flatter his own nation in the character of their supposed progenitor and to persuade them, that the empire, which they had usurped over the rights of nations, was founded in the immutable decrees of the Fates.

Upon the whole it does not appear, that Homer at all, and Virgil very little, if at all, wrote under the influence of a refined and subtle moral. Of other epic poets among the ancients, if epic poets they may be called, such as Lucan and Statius, it is hardly pretended, and therefore this moral, which is so interwoven with the fine-spun theory of the critics, from Aristotle down to Bossu, to which the whole poem is to be subservient and for which all the celestial machinery is provided, may be little better than a dream, like the allegorical creation of the gods, who act so distinguished a part in the ancient Epopœa, which is to be the subject of our next examination.

PART II.

The principal object, for which this essay was undertaken, remains for the consideration of the present evening, viz. dismissing the supposition of any one great moral and the allegorical interpretation of a more than human machinery, as subservient to the illustration of this moral, let us receive the epic poem of the ancients with its terrestrial and celestial agents, and enquire, whether the ancient Epopœa derives any advantage from the introduction of this supernatural machinery; whether, the character of the gods and goddesses of the Greek and Roman heaven being in every view inferior to that of men, the assigning to such contemptible personages so principal a part does not detract from the interest, and debase the dignity of the poem, whatever the genius of the poet may be. I know, that in this attempt I have prejudices to encounter, prejudices, which, having entwined themselves about our hearts in the dearest and most enchanting period of life, still retain a mighty power and subjugate almost reason itself. But if there be a truth in character, if there be a standard in nature, to which taste and judgment ought to

bow, to this truth and standard I appeal, and in despite of the dearest prejudices hope to make it appear, that, inasmuch as the ancient epic poem depends upon its celestial machinery, this machinery is a puerile and miserable ally, having no consistency, no dignity of character, serving to no great or good end, exhibiting no sublime or moral lesson, beneath human nature, and, having in itself no excellence or elevation, can administer no aid, reflect no lustre on the poem, which adopts it.

I shall examine this machinery of the ancient epic in these two views,

I. Whether it contributes to the moral, or morals of the story.

II. Whether it contributes to raise the imagination, to exalt and excite in a higher and more interesting degree the passions, in which the epic peculiarly delights.

I. If it be admitted, that instruction and moral instruction should be a principal object of the sublimer epic, this end is not only not promoted, but absolutely perverted by the introduction of the heathen deities and the important part, which is assigned to them in the ancient poem. Whether moral instruction be a principal end, or no, yet it is certainly required of poetry in general, and much more of the graver and severer poetry, that it have a

decent regard to moral, that it do not corrupt, if it do not improve. We turn away from the Pierre of Otway and the Horneck of Wycherley, with as much aversion as from Catiline and Clodius, and, though all the art of Otway (which must be acknowledged to be great) be exerted to interest us in the fortunes of his hero, yet the feeble and transient sympathy, which he can awake, cannot overcome the fixed abhorrence, which the villainy of the character has aroused. It is the happiest talent of a poet to insinuate instruction without appearing to intend instruction, the heart is taken by surprise, it is met in its native innocence, and the most virtuous emotions are excited and the most exalted lessons are impressed. Of this talent Shakespeare is a rich example and, in the exercise of this noble talent, he has made a rich atonement for his occasional playfulness and wantonness. I will not say, that in him the impressive moral of the stage has surpassed that of the pulpit; from me this concession would not be expected, nor perhaps be credited; but this I will say, that in representing the vanity of all human grandeur and power, especially when mixed with crime, and when, at the close of life, the mind is looking back on the scene, that has been passed, I could wish even from

the pulpit to exhibit the delicacy and power, with which he has insinuated the lesson of innocent moderation and content, in the pathetic soliloquy of the care-worn monarch, Henry IV.

——— Oh sleep, O gentle sleep,
Nature's soft nurse, how have I frighted thee,
That thou no more wilt weigh my eye-lids down
And steep my senses in forgetfulness?

Then, after some lines of the sublimest conception, in which, with the most splendid imagery, is contrasted his own elevated rank with the lowliest situations in life, he closes with this affecting apostrophe, wherein, without the form of one moral precept, he reaches that moral conviction, which Solomon, with all his graver wisdom, perhaps, shall fail to attain.

Canst thou, O partial sleep, give thy repose
To the wet sea-boy in the rudest hour
And in the calmest and most stillest night
With all appliances and means to boot
Deny it to a King? Then, happy low lay down;
Unhappy lies the head, that wears a crown.

The preceding character of Henry, as portrayed by Shakespeare, suggests this additional line, in which the dignity of the moral lies,

A Crown embittered with the sense of crime.

The example of Shakespeare, in a walk of poetry not greatly different from the epic, is alone sufficient to support me in this absolute position, that the genius of the graver poetry should never be opposed to the interests of virtue; and, though we read not an epic poem with the same view as a book of Ethics, yet that the sentiments obtruded by the former should, at least, not be contrary to those, which are inculcated by the latter.

But the divinities of Greece and Rome defy all moral and their character of divinity operates directly to the subverting of all moral. Folly and wickedness in human agents may be exhibited by the poet, or historian, with the highest moral utility, and without detracting from the dignity of the work; but not so, where deity and the only deity, whom we know and acknowledge, is presented to our view. Weakness, caprice, passion and crime in them dig up the very foundations of honour and virtue in the human mind. There is no alternative between this effect and pure atheism, or the abandonment of all religious principle whatever; and, perhaps, the latter is less to be dreaded. It is surely better, if no better faith can be found, that from a sense of dignity and virtue, which we cannot part with, we should revolt from religion, than adhere to

a religion, which confers a sacredness on every baseness and vice. Yet such is the character, and such the influence of the whole pantheon of the ancients, the Dii Majores or Minores, in all the exhibition of them. It is with all their follies and with all their crimes upon their heads, as received by the popular faith, that they are introduced in the poem, and as auxiliaries to the heroes of the poem.

The Pater Hominumque Deûmque, the Supreme Jove, makes his first appearance in the page of heathen mythology, as dethroning his father and marrying his sister, whom, according to some authors, he had previously debauched. But nor the united relation of sister and wife, nor the divinity, nor perpetuity of youth as the attribute of divinity, nor the majesty of person, nor the lustre of her large blue eyes, in which Juno surpassed all the beauties of the celestial court, could secure the matrimonial fidelity of this Deus optimus maximus. Ungoverned and wide-ranging lust is the first feature of his character, and his history is that of a libertine, who, by fraud, by corruption, by false appearances, or open violence, subjects every woman to his will, whose unfortunate beauty excited his desire. And too often, with all the apathy of a sated libertine, he leaves the hapless victims of his

lust, to be the farther victims of the relentless jealousy of his offended queen. On the story of Clitoris, whom he violates in the shape of an ant, Vossius very gravely remarks, that thereby the ancients meant to inculcate, "Quod ingentia plerumque a minimis mala oriuntur." What does not the heathen mythology owe to the ingenuity of some christian moralists? The halter is not, indeed, a "dignus divino vindice nodus," but unprotected by supernatural power, this in our days would assuredly terminate the career of such a libertine on earth. There is, in a passage of Terence, a striking attestation to the pernicious influence, which the character of the supreme Jove must have upon the moral mind. A young debauchee justifies his conduct by the plea of Jupiter's example. Terence wrote in the purer days of the Roman Republic, and that in these days a Roman audience could bear such an appeal, in behalf of licentious amour, is a strong proof, that the reflection was not singular, but that it was familiar perhaps to every one, who received this immoral deity as the supreme object of his worship. With this character for licentious amour and unrestrained lust, Jupiter is acknowledged in the epic poem of the ancients. And such as the

Pater Deorum is, such are all the subordinate gods, who act their parts in the epic scene.

> Quisque Deus, Mars, Bacchus, Apollo, Venusque,
> Pessima sunt exempla lubidinis irrequietæ.

Equally immoral is the lesson, which the providential government of this unprincipled god must convey. Here no great and unchangeable laws of justice present themselves to our view, but all the fluctuations of capricious favoritism and prostituted power, without regard to the distinctions of right and wrong. A wife, a daughter, a son, a brother or a mistress, wheedles by turns this repository of supreme power, and points his thunder against the objects of their partial resentment, though in opposition to the prior determinations of his own mind. Take a slight view of his conduct through the Iliad alone.—Thetis, from the worst of motives, to gratify the pride and passion of her son and avenge a private affront on his whole country, solicits the interposition of Jupiter to befriend the Trojan arms, and bring disgrace and defeat on the Grecian host. The easy god yields to her malicious request, and influences Agamemnon to lead forth his army to battle, as a designed sacrifice. By the temperate counsel of Hector, the bloody conflict is suspended, and Jupiter,

as if forgetful of his promise to Thetis, is bullied by Juno to disgrace the cause of Troy and awake the vengeance of the irritated Greeks. To effect this purpose, he gives the sanction of his godhead to an act of the most dishonourable treachery, he sends Minerva, the goddess of wisdom, on this base errand, to incite some Trojan chief, in the security of the truce, to aim a deadly arrow at the breast of Agamemnon. The war is re-kindled in all its fury, and falls heavy on the Trojans, who, unprotected by Jupiter, are exposed to all the malice of Juno and Minerva. After great irresolution and inequality of conduct through several books of the Iliad, Jupiter seems to recollect his promise, and by his direct and indirect interference, the tide of victory runs strong in favour of the Trojans, and the Grecian army and fleet are brought into the most imminent danger of destruction. From this desperate situation the Greeks are rescued by the arts of Juno. Knowing the weak side of her husband, and that the allurements of beauty are irresistible to him, she summons every charm in aid to her person; by flattery and lies she obtains of Venus that cœstus, to which a thousand graces are attached, and, thus attired, she seduces Jupiter to the idle dalliances of love, and diverting his attention from the Trojan plains,

other gods lend their succour to the Greeks, awake their courage, and the Trojans sink under their united attack. Jupiter, at length recovering from the lethargy of lust and sleep, beholds the sad reverse, which his Trojans had experienced during this fatal interval, and indignant at the imposition, which had been put upon him, he threatens the seductive author of it with all his vengeance. Here another trait of moral mind in this divine consort of the super-divine Jove presents itself. To her husband's accusation of her having instigated Neptune to take up arms in behalf of the dispirited Greeks, during his own amorous delirium, she swears to as great a falsehood as ever issued from the mouth of woman in her most pressing exigence. She confirms the lie by the strongest adjurations, by the dread power of Jove, by Styx, and more than all,—by that unbroken vow, her virgin bed,—that at no instigation of her's had Neptune turned the current of war in favour of Greece. But such is her own obstinate malice against Troy, that having withdrawn from the presence of Jupiter, to whose will she had vowed submission, while alarmed for her own safety, she instantly endeavours to effect her purpose by exciting the whole assembly of the gods to an open conspiracy and rebellion against the

sovereign majesty of heaven, their lord and her lord. Such are the personages, whose favour and protection are to throw a lustre on the mortal heroes of the poem, and whose characters are to facilitate, and confer a dignity on the moral instruction of the poem.

It would, indeed, be tiresome and disgusting to bring forward into your presence any other of the celestial actors in the Epic, in the view of moral; nor is it my intention to prosecute the disgusting detail. Such as Jupiter and Juno are, such are they all, with little if any variation of character. The amour of Venus with Mars in the very court of heaven, and the exposure of the adulterous pair to the assembled gods, are a charmingly moral picture, and such gods are wonderfully calculated to aid the sublime views of the Epic Poem. In whatever light we view them, this is the general picture of them, that they are capricious equally in their favour and their anger, profligate in their manners, wicked from principle as well as passion, interposing with their aid from no regard to justice or virtue, and where their vengeance falls, oppressing their human victims as their pleasure leads them; and often for no reason, but that of tyrants and cowards, because their hand is uppermost. No instruction of worth and dignity can come from them,

they corrupt, they co-operate with every evil passion, and familiarity with them is not favourable to good impressions, even where a better faith is received and acknowledged.

But, perhaps, it may more interest you, if I shall shew that they are as contemptible as they are immoral; that they constitute as puerile and feeble and uninteresting a machinery, as imagination could ever think of associating with human agency, in order to embellish and illustrate the imitations of real genius.—For,

II. If instruction be not promoted, but in truth counter-acted by the machinery of the ancient epic, neither are our imaginations raised, nor our sublimer and more noble passions at all affected by the exhibition of such characters. In themselves, whether in their actions on earth or in heaven, whether as mixing with men or each other, they appear with no consistence of character, with no grandeur of mind or action, generally more the objects of contempt than reverence, more adapted to the satirical ridicule of Lucian, than to adorn and dignify the Epic Poem. How mean and low, how unsuited to the gravity of the heroic muse, are the feuds and quarrels and brawls of these gods and goddesses with each other; how below even the con-

duct of men, when committed to the influence of the same indignant and conflicting passions. How truly vulgar is the abusive tongue of Juno! How little superior to the impotent rage and gross language of a Billingsgate fish-woman! Nor less does Venus descend in her replies from the character of the Queen of Love and Grace and Smiles. If they be beings above the walk of men, they ought, even in their passions and vices, to be clothed with a dignity superior to human actors; but even human nature blushes for them. And are such exhibitions fitted to exalt the imagination, to stir one great and generous emotion of the soul? How pitiful is the blubbering of Mars, when like a child, whose finger a pin had scratched, he comes whimpering into the presence of his papa, Jupiter, and complains, that the man Diomed had disgraced him in the field, and shed his divine Ichor on the Phrygian plain. The limping gait of Vulcan, and his form and dress and manners adapted to his profession, or the scurrilous wit and jests of Momus, such as of a court fool in the palace of a feudal monarch, present a buffoonery, which would disgrace the banquet of men, but must sink the character of gods during their convivial intercourse into absolute contempt. Are such the images, which the epic muse can

descend to? Can these excite one noble passion? 'Tis not the will of the implacable Juno, though next in rank to the sovereign of heaven, which can raise the bosom of the yielding ocean, and threaten the destruction of the hated Æneas and his fleet, but her majesty must supplicate the aid of a savage god in some wild region, who has the winds imprisoned in a cave, and she debauches him from his duty by the promise of a beautiful mistress. How ridiculous is the personification of these winds, who, from the volume of their lungs, can emit a power, sufficient to convulse all nature.—The Icelandic Edda would be disgraced by such a deification, nor is the idea of a Lapland witch imprisoning a storm in a leathern bag more contemptible. Cotton has done them no injustice in his ludicrous exhibition of their modus operandi. What a rabble of gods and goddesses is exhibited to our view among the Dii Minores of the heathen mythology! How low in their characters! How mean in their functions! Yet they all have a supposed being and ministration, and all occasionally have their parts assigned to them in the Epopœa of the ancients. The Satyrs of the Woods, with their shaggy bodies, and their lustful propensities, the worthy attendants of the drunken Bacchus; the god Pan with his

half human, half beastly form; the ugly, pot-bellied, drunken Silenus, the fit preceptor of Bacchus; the versatile Proteus, with his Cameleon transmutations and followed by the deified monsters of the Deep; the sooty blacksmiths in the caverns of Mount Ætna; the infernal gods, not less horrid in their persons than in their minds, not ill prefigured by the three-headed porter of hell, whom a greasy sop can debauch from his duty, with a thousand more, constitute altogether a magnificent group; they form a glorious addition to the Dii Majores, whom we have contemplated; they furnish a splendid imagery to grace the sublimer poetry of the ancients.—There is, indeed, in the personification of the ideas of the mind, or of the rich scenery of nature a real poetic beauty, which man delights in, which gives animation and power to language; and this is a propensity common to men; it is not peculiar to the heathen mythology, it has been the common vehicle of human description in all ages and nations. But these have no resemblance to the rabble, whom we have noticed; this rabble have a being and appropriate agency, and can with no dignity, with no beauty, be introduced into the higher walks of poetry.

If we look in vain therefore, for grand and

splendid imagery in the celestial machinery of the Epic, what is there left of worth in it, if it aid none of the rich sympathies of the heart, which are the principal feast that it looks for in the various exhibitions of the poetic muse?

But it is a farther charge against the officious interposition of the heathen deities in the ancient epic, that it annihilates man, or sinks him into comparative insignificance, and thus destroys, or chills that sympathy, which is the attractive charm of historic poetry.

The heroism of fellow man, derived from the resources of human nature, is always an interesting object; but its impression is weakened, inasmuch as we refer it to the interposition of a supernatural agent, especially of such contemptible agents, as are the heathen deities, in whom we behold nothing but power, stimulated by no moral or generous impulse, directed to no wise or good end. Our sympathy with the man is defeated, for the man is not in sight, he is to us no more than the vehicle; nor can we sympathise with the real agent, for he is removed beyond the field of human sympathy; nor do we behold in him that dignity of character, which renders his interposition desirable, or interesting. The disgraceful character of their gods casts a dark shade over every scene, in which they are in-

troduced, and, if their power sometimes raises them above human kind, their caprices, partialities, and vices sink them much below the human level. But it is to the reproach of the ancient epic poems, that the gods are generally introduced, where their agency is superfluous, and where human agency is fully sufficient. It is almost laughable to contemplate the queen of heaven and the queen of smiles, uniting their superior agency to do—What! to bring Æneas and Dido to bed together; which, if necessary to the plan of the poem, might well enough have been left to plain human nature. If the reconciliation of these two contending deities, so as to be consistent with the separate views of each, required the event; yet it must be confessed, that their divine wisdom adopted a rather vulgar method of accomplishing it. It might have been managed as an affair of ingenuous love; and, if deities must be summoned, Juno might have bestowed all her majesty on the hero, and Venus all her seductive graces on the Carthaginian queen. Thus the event would have been accomplished with more grace and dignity, the frailty of the fair one would have been more extenuated, and the gallantry of the Trojan better supported; while it would have afforded a rich field of elegant

and affecting description to the poet. But I mention not this as the most objectionable introduction of heathen deities into the ancient epic. The passage, as it has issued from the pen of Virgil, is full of beauties. More truly ridiculous and disgusting interferences of the celestial machinery abound.

Sometimes, indeed, the representation of the persons of the deities summons all the genius of Homer and Virgil, of each in their respective line of excellence. The majesty of Jove by the former, and the grace of Venus by the latter, are animated descriptions of the grand and the beautiful in the human form. The one gave existence to the statue of Phidias, while it is not improbable, that the Medicean Venus suggested to Virgil his conception of the Paphian queen. There is a correspondence of form and elegance in both, and the *vera incessu patuit Dea* is presented in the perceptible and almost inchoate movement from the pedestal, which is so happily expressed in the statue.

Homer and Virgil were poets of the first order. The question is not with them, but with the foolish and contemptible deities, whom the faith of their day imposed upon them.

There are two ways, in which the superna-

tural beings interfere with the human actors of the poem. The one is by a kind of inspiration, elevating those, whom they favour, and depressing and terrifying those, whom they hate and persecute. This to a poet may, perhaps, be tolerated, though it is a miserable exhibition of the popular divinities, and accounts too well for the debased moral of the heathens, their partial affections, their vindictive and implacable passions, their want of all sympathy for man as man. It may be considered in this way, as a mere poetical fiction or imagery, conveying in more emphatic terms the idea of the grand, or the terrible. But the poetical illusion vanishes, when in the second way these deities are personally introduced on the stage; never above, generally below the standard of men; serving to no purpose but as the necessary appendages of a national poem, or as a sacrifice to a political religion, but derived from a popular faith, which was the very dotage of a low, gross, and vicious superstition.

Of this second class are the following instances, which, among many others that might be adduced, it may be sufficient to notice.

Diomed is a warrior of the highest order. Is his heroism exalted by the personal accompaniment and co-operation of Minerva?

——— She the man inspires
Strong in her strength, and warmed with all her fires.

Æneas is in the most imminent danger from his resistless arm. Thus far is still tolerable, and, by a little more strain of the imagination, Minerva might still be considered as but a representative of the hero's personal valour.—But Venus personally interposes to rescue her mortal son. She is foiled and wounded in the attempt; nor does Mars himself, the dread god of battles, fare better, when opposed to the martial goddess in the person of Diomed. Surely this is heroism in burlesque. Those who can admire such a scene, must, methinks, have submitted their taste and understanding to as low a standard, as it was reduced with the heathens by their wretched theology.—Though Homer told the tale, as he probably received it from tradition, yet it seems as if he felt the ridiculousness of the scene, when he sends the discomfited god blubbering up to the court of heaven, and impotently urging his complaints before his divine papa, who only mocks his sorrows.

But that the poet meant more than mere poetical allegory, by summoning his deities to the aid of his mortal combatants, is evinced by their humiliation in moments of difficulty and

danger, when deserted by their heavenly assistants.

Hector is certainly a favourite character with Homer, both as a warrior and a man. He is, indeed, in every view, the most illustrious hero of the Iliad. From the gallantry of his spirit, he challenges the bravest knight of Greece to the combat. Ajax steps forth from the Grecian ranks to meet him. He is appalled at the tremendous figure of his antagonist, but, though disdaining to fly, and summoning to the encounter both the soul and the resistance of a hero, he sunk under the blow of an immense stone, hurled from the brawny arm of Ajax, and must have perished, but for the intervention of Apollo, who, in the form of a Vulture (a sublime representation to be sure of such a god!) had been contemplating the combat. Homer, if he had pleased, could have rendered his hero victorious, by the more active and timely intervention of the same favouring deity. Hector is not disgraced, but he is conquered. Such is the combat of men, sustained only by the energies of man. But Hector is indeed disgraced, when in the combat with Patroclus he conquers, and his disgrace arises from the interposed assistance of a god, one of the puppets of this childish machinery. There is nothing in the preceding

history of Patroclus, which entitled him to be exempted from the honour of falling under the unaided arm of Hector, as Homer had repeatedly exhibited him. To this unnecessary interposition of a god is added the farther disgrace of Hector's unmanly triumph and insult over his prostrate and dying foe. Patroclus, in the agonies of death, justly replies;

> Vain boaster! cease! and know the powers divine,
> Jove's and Apollo's is this deed, not thine.
> To heaven is owed whate'er your own you call,
> And heaven itself disarmed me ere my fall.
> Had twenty mortals, each thy match in might,
> Opposed me fairly, they had sunk in fight:
> By fate and Phœbus was I first o'erthrown,
> Euphorbus next, the third mean part thy own.

Homer has, however, rendered poetic justice to the hero, whom, in subservience to his celestial machinery, he had thus disgraced in his combat with Patroclus; for, without the aid of Minerva, the never-failing champion of the Grecian cause, even Achilles, that goddess-born and invulnerable hero, on whose forbearance alone the fate of Troy seemed to be suspended, was not enabled to conquer the very man, who was so unequal to the encounter with his friend. To effect a death in battle is not a *nodus, divino vindice dignus;* the machinery is a poor and artless refuge; the poem

sinks in dignity; and human heroism, its only proper subject, is debased. Virgil, too servilely copying his model, has, in the last conflict with Turnus, dishonoured Æneas, in whose person he intended to do honour to the Roman story. Æneas conquered, not without a divine assistance, the King of the Latins knew from whose hand his death issued, he renders no homage to Æneas, his last words are,

> ——————— I feared no death from thee,
> Jove and a fiend from hell, have conquered me.

What is there then, which, in an appeal to taste or judgment, can plead with a modern the cause of the heathen deities, as an auxiliary of the ancient epic poem. The mythology of Greece and Rome is the most contemptible creation of man. We observe in it no whole, but a motley composition, formed out of discordant materials, loosely adhering, and altogether presenting neither dignity, nor elegance; nor even the playful luxuriance of a wild but captivating fancy. In its gross, ferocious and brutal part, it most resembles the Icelandic Edda; what claim it has to elegance and taste, as in the fiction of Venus and Cupid, appears to be derived from the licentiousness of the Syrian goddess, or in the animation,

which it gives to all nature, from a poetic imagination, common to man in every age; and with the whole are incorporated the irregular and desultory actions of mere men of some early and rude age; altogether forming a most incongruous mass.—Had it been permitted to Homer and Virgil to have adapted this machinery at their discretion, and as a vehicle of dignified and elegant moral, it is to be presumed, that they would have moulded it to their purpose with more taste and judgment. But obliged to receive it with all its absurdities and fooleries and grossness, its character in the appeal to true taste appears to be, that it disgraces their poems, presents an immorality beyond the utmost licentiousness of man, debilitates the human story, and in the most interesting exhibitions of human character, which constitutes the principal interest in the Epopœia, takes the human agent out of the field of human sympathy, by placing him under the direction and controul of a more powerful, but more capricious and immoral agency.

Homer, in all probability, entertained as little doubt of the theology of his day as any of his rude and unpolished countrymen, and therefore, without scruple, admitted into his poetic history of the wars of Troy all the crudities of the popular superstition, with

which tradition had liberally intermingled it. The faith of the Greeks and Romans appears to have contemplated their supposed divinities, as having no nobler occupation than to be busied with the interests and passions and prejudices of men, and, though the expedition against Troy had no higher end in view, than to recover a beautiful adulteress from the arms of her paramour, who had also violated the rights of hospitality, yet they deemed the cause of sufficient importance to interest the whole court of heaven, and thought the gods, to whom they ascribed the most partial and puerile affections, would enter into the quarrel, and agreeably to their several inclinations range themselves on the part of Greece or Troy, without any regard to right or wrong. Homer, therefore, without a sense of impropriety, might deem the celestial machinery to be an embellishment of his poem.

But it was not so with Virgil. In his day philosophy had made considerable progress, and therefore no light and easy faith can well be ascribed to him. He was a Stoic, and must have imbibed a thorough contempt for the fooleries of the popular creed. But this popular creed no Roman, however sceptical, ever publicly insulted; it was a powerful instrument of state policy, and though philosophy

had taught the politer Romans to despise the religion of their country, philosophy had not supplied them with any purer and nobler faith. Virgil found a tradition, no matter whence derived, that the founders of Rome, and particularly the Julian family, were descended from Æneas, and that to the posterity of this Trojan was promised extended empire, while already the Romans had avenged on Greece the cause of ruined Troy. On this ground, to flatter his country's pride gave birth to his admired poem, as this is interwoven with the whole structure of it. Whatever, therefore, for himself he might think, the design of his poem, which was, in fact, a sequel of the history of Troy, required that he should take the gods of his country, as he found them, which was also as Homer left them; and this being a state of admirable preparation for his purpose, he well knew that if he did but manage them so as ultimately to flatter the ambition of Rome, this would constitute the strongest recommendation of his poem. To what degree his poem must have gratified the Roman people, may be inferred from the applause, and almost adoration, with which he was received, whenever he presented himself to the public view. That Virgil, however, was not overpleased with his celestial puppets, may be presumed from this

cirumstance. Though following the steps of Homer, he follows him less in the use of his machinery, than in any other path. There is in the Æneid more of human character, displayed in more varied action, and with less intervention and controul of supernatural agency than in the Iliad. The two poems have this characteristic distinction. Virgil's is the portrait of men, Homer's that of the gods.

It would be a not incurious subject to compare the poems of Homer and Milton. They are not unlike in several respects. As Homer's has been observed to be the history of gods, Milton's may be said to be that of devils.—The gods of the one, and the devils of the other are nearly of equal credit; the former altogether, and the latter for the greater part, being the creatures of a popular and fabulous superstition. Homer had his Pantheon, Milton his Pandæmonium, each their courts and councils, and each a supreme regent. But wherein they differ, the difference is immense in the estimation of the two poems, with respect to their supernatural machinery. Willing or unwilling, man was subject to the caprice and violence of Homer's gods, and these gods usurped over the whole field of human action. While only by the consent of his own will

could man be subjected to the influence of Milton's devils; and, if suffering under this influence, had still his refuge in an Almighty, wise and beneficent being. From the tyranny of Homer's gods man had no refuge whatever. In the court of Homer's heaven all was discord and misrule; god was opposed to god, and all the pretended power of Jove was impotent to reconcile the contending deities, or by awe reduce them to submission. Milton's Satan was truly sovereign, and an union of sentiment and design pervaded the whole of his gloomy domain. Milton's devils, though wicked beyond the stile of Homer's gods, are uniformly grand, they exhibit that sublime of the terrific, which the epic aspires to. Homer's gods, though wicked enough, are as foolish and freakish as they are wicked, they are not superior to what we may conceive of the lowest rabble in Milton's hell. I enter not into the heaven of Milton, and, perhaps, it would have been as well, if he had not so familiarly unveiled that sacred region. But there Homer presents no parallel, and the comparison fails. The picture of man also in the two poems is greatly in favour of Milton, and shews the advantage, which is derived to the mind, that has received a purer and nobler faith. Indeed to illustrate this advantage and by contrast excite a stronger im-

pression of the meanness and grossness and worthlessness of Homer's supernatural machinery was my direct view in this comparison.

We have seen under what circumstances Homer first and Virgil, from his example, were led to adopt this machinery, and give to it so principal a part in their poems. But whatever circumstances submitted their genius thereto, impose no fetters on the more correct and chastened taste of a better day. True taste and judgment are unyielding and unalterable, the plea of the man cannot alter the character of his work, nor any circumstances make that allegory, which is history, that moral, which is wicked, that dignified, which is puerile and contemptible, those heroes, who are machines, nor excite sympathy, where the field of sympathy is destroyed. To support this charge against the use of the gods of Greece and Rome, as the machinery of the ancient Epic Poem, has been the object of the whole essay, illustrated in a regular examination of the allegory, the moral and the passions. The decision is left to your judgment.

If a supernatural machinery be requisite to an epic poem, it is certainly not to be sought for in the imagined inhabitants of the Christian Heaven. I think it would be found, if any

one of superior talent would attempt it, in the Genii, evil and good, of the eastern religions. It is not owing to any inherent defect in the conception of this machinery, that it does not greatly interest us in the eastern romance; it is managed by the writers of the East to its highest advantage; they are deficient in taste and judgment, as must ever be, where man is not exhibited in that rich display of character, manners and moral, which the progress of western Europe has brought forth to view.—The eastern mythology is fitted for a more grand and interesting production of the epic than Greece or Rome has yet furnished. The Genii of the East, though the creatures of imagination, are not much out of the field of probability; they may be clothed with what magnificence and what consistency of character we please; they comprehend all the machinery of Milton, his Pandæmonium, and the agency of benevolent spirits, without that offence which the introduction of the sacred personages of the Christian Heaven excites, and to give a sublime and moral dignity to the whole, the controul of a sovereign Providence is, with the highest propriety, admissible.

OBSERVATIONS

On the Effect of Madder Root on the Bones of Animals.

By Mr. B. GIBSON.

Read April 10, 1801.

THERE is, perhaps, no phenomenon, which occurs in an animal body more curious, than the tinge communicated to the bones of living animals, whose food has been mixed with madder root. This, like many other facts, to which no reasoning *à priori* could have directed us, was discovered by chance. Mr. Belcher, dining with a calico printer on a leg of fresh pork, was surprized that the bones, instead of possessing their usual whiteness, were of a deep red colour; and on enquiring the cause of it, was informed, that the pig had been fed upon the refuse of the dyers' vats, and had received so much of the colouring matter of madder into the system, that its bones were dyed by it. So interesting a fact has attracted very much the attention of anatomists, and has been used in many physiological and pathological enquiries; it may not therefore be uninteresting to give a short

history of the phenomena connected with it, and the purposes to which it has been applied, previous to entering upon the more immediate object of this paper.

Many experiments have been made to ascertain how long a time is required to produce the tinge, and whether it be permanent or only temporary. Belcher and Morand, about the same time, mixed madder root with the food of chickens and young pigeons. The result of their observations was, that the tinge was more quickly communicated to the bones of growing animals, than to the bones of animals which had already completed their growth; the bones of young pigeons being tinged of a rose-colour in twenty-four hours, and of a deep scarlet in three days; whilst the bones of adult animals only exhibited a rose-colour in fifteen days. They found the tinge most intense in the solid parts of those bones, which were nearest to the centre of circulation; whilst in bones of equal solidity, at a greater distance from the heart, the tint was more faint. The dye was deep in proportion to the length of time the madder had been continued, and when it was discontinued, the colour gradually became more and more faint, till it entirely disappeared. According to the experiments of these gentlemen, other

other vegetable dyes, such as Logwood, Turmeric and Alkanet Root, did not communicate their respective tints to the bones.*

This effect of madder upon the bones, was soon afterwards made use of by Du Hamel, in his attempt to prove the manner in which the bones of animals are encreased in thickness.—Observing in the vegetable kingdom, that the bark, by a sort of secretion, formed the ligneous part of a tree, in successive layers; so he conceived that the periosteum, or membrane surrounding bones, being converted into osseous matter, encreased their diameter by adding to them concentric laminæ in succession. In order to prove the justness of his opinion, he mixed the food of a cock with madder root for a month, withheld it for a month, and then

*From some experiments I made on young pigeons, I found that a considerable quantity of logwood, in the form of extract, communicated an evidently purple tint to the bones. With regard to turmeric, it appears to be altered in its colour by passing through the digestive organs, for the fæces of the animals, who took it in considerable quantity, were constantly green: whilst either logwood or madder root exhibited their respective hues after passing through the intestines. Saffron exhibits properties different from any of these substances; for though a pigeon took it in considerable quantity and thereby had its fæces tinged, yet no perceptible alteration of colour was produced in its bones.

gave it again. He afterwards killed the animal, and upon inspection thought he observed the appearance, which he expected; viz. two layers of red bone inclosing one of white, corresponding to the periods of the madder's being given or withheld.

This experiment, and some others related by Du Hamel, appear to be conclusive in favour of the theory, which he wished to establish; and as they were conducted by a physiologist of high character, the accuracy of the observations could not have been doubted, had these experiments stood alone. But when they are compared with some of his own previous experiments, and those of other authors, it is difficult to reconcile them. In some of Du Hamel's experiments, for instance, the bones of a cock were tinged of a rose-colour through their whole substance in sixteen days, and those of young pigeons of a deep scarlet in three days. In several experiments I have made on the subject, I have found the bones of young pigeons tinged of a uniform rose-colour, internally as well as externally, in twenty-four hours. This communication of colour to the whole substance of the osseous system in so short a time, makes it highly improbable that the laminated appearance, remarked by Du Hamel, was produced by the

new formation of red and white osseous layers, corresponding to the times (months) the madder had been given or withheld. For, as Mr. John Bell very justly remarks,* "If a "bone should increase by layers thick enough "to be visible and of a distinct tint, and such "layers be continually accumulated, upon "each other every week, what kind of bone "should this grow to?" The only way in which we can reconcile with each other the phenomena observed in the different experiments, and account for their apparent contradiction, is; by supposing, that Du Hamel mistook for an obscurely laminated appearance, the variety in the tint, which is more deeply communicated to the more solid, and more faintly to the less compact parts of a bone.

This property of madder of tinging the bones of animals, has lately been employed by Dr. M'Donald,† in his ingenious researches into the formation and death of bones.—— Amongst other objects, he attempted to ascertain, in what manner and how soon, a cylindrical bone is regenerated to supply the place of one artificially killed. As the process is highly curious, I shall briefly relate the principal points.

* Anatomy of the bones, &c. p. 15.

† Disputatio inauguralis de Necrosi ac Callo. 1799.

Dr. M'Donald's experiments were made by amputating the proper leg-bone of young pigeons or chickens immediately above the joint. The marrow was then extracted, and the cavity, which contained it, filled with lint. This process caused the death of the bone, and the formation of a new bone surrounding that destroyed, ensued. Immediately after the experiment, the animal had its food mixed with madder root, and the part was inspected in different animals, at different periods.

On examination three days afterwards, the periosteum or enveloping membrane, was found much thickened; and underneath it a gelatinous humour was effused, surrounding the dead bone, and spotted with red osseous nuclei; proving that the regeneration of the bone had commenced at this early period.

In seven days the new bone was found soft and flexible, not to be distinguished from cartilage or gristle, except by the red tint the madder had communicated to it; yet the bone destroyed was not at all coloured, although the other bones of the animal had acquired a bright red. From this time the new bone continued to encrease in hardness, surrounding the old one like a sheath. The latter in about three weeks was so loose as to be drawn out, and in about fifteen days from this time, the cavity

of the regenerated bone was filled with marrow, and in every respect performed the office of that, for which it was a substitute. This may be considered as a general outline of the progressive changes, which take place during the regeneration of a cylindrical bone, in a young animal, such as a pigeon, or chicken; and the same process is frequently performed in the human body, when, from some internal cause, the life of a bone is destroyed. These changes involve many interesting particulars; but the circumstance most immediately connected with the subject of this paper is, that although the shaft of the bone required three weeks for its renewal, yet in seven days the osseous system generally had acquired a bright red. Now if we explain this change in colour according to the common opinion of absorption of the white, and deposition of the red osseous matter,* we must necessarily draw

* The common opinion of physiologists, with regard to this curious fact, is, that when a bone becomes red, during the exhibition of madder root, the white osseous particles which composed it, have been entirely removed by absorption and replaced by new osseous matter of a red colour: and when a bone assumes its natural colour, these red particles have been removed and replaced by white. If this be the fact, it necessarily follows, that an animal has at least fifty-two new sets of bones in a year:

this conclusion; that the osseous system of the animal will be renewed three times during the period, which the formation of the substitute bone requires; a conclusion which we should be inclined to reject merely from its improbability. But besides this, the appearance of the parts strongly militate against it—for, if we may judge at all of the activity of the process in the two parts, by their comparative degrees of vascularity, that employed in forming the substitute bone far exceeds that going on in the osseous system generally; one striking phenomenon attending the regeneration of a bone being, the very high degree of increased vascularity, which the parts employed in the process rapidly assume.

After this effect of madder upon the bones was known, it long remained a mystery, why some other white parts of the body, such as nerves, cartilages and periosteum, were not equally liable to be coloured by it, as the bones. This fact, I believe, did not receive any explanation, until Dr. Rutherford gave a very ingenious and satisfactory one. When speak-

for the osseous system, according to the experiments of the most respectable physiologists, acquires a deep red tint from madder in one week, and assumes its natural colour in another.

ing of this property of madder, he says,* "We "have, in the fact before us, a beautiful ex- "ample of a particular case of chemical at- "traction; such as in numberless instances, "is observed to take place, between the co- "louring particles of both animal and ve- "getable substances, and various other bodies, "especially earths and earthy salts, and oxydes "of metals. So strong is the affinity of the "colouring matter to these bodies, that it is "frequently observed to quit the menstruum, "in which it may chance to be dissolved, to "unite with them: they, in consequence of "its union, acquiring a particular tinge, "whilst the menstruum is proportionably de- "prived of colour.——From this principle, "this mutual attraction, is deduced the va- "rious use of those bodies as mordents, as "they are called, intermedia, or means for "fixing the colours in dying or staining thread "or cloth, whether it be composed of ani- "mal or vegetable materials. Upon the "same principle depends the preparation of "those pigments, known to painters under "the name of lakes; these are truly precipi- "tates of the colouring matter, in combina-

* See Dr. Blake's inaugural Dissertation. De dentium formatione. p. 119.—1798.

" tion with various mordents, as their basis.—
" the colouring of the bones of a living animal
" by means of madder, is, in every circum-
" stance, analogous to the formation of these
" lakes. The colouring matter of madder,
" passing unaltered through the digestive
" organs of the animal, enters the general mass
" of fluids, and is dissolved in the serum of
" the blood, to which, indeed, if it be in
" large proportion, it communicates a sensibly
" red tinge. *But there is always present in the*
" *blood, and in a state of solution in the serum,*
" *a quantity of the earthy matter of the bones,*
" *phosphate of lime, ready to be deposited, as*
" *the exigencies of the animal may require.—*
" *Now the phosphate of lime is an excellent*
" *mordent to madder and has a strong affinity*
" *to it, and is consequently admirably fitted to*
" *afford a base for the colouring matter of it;*
" *in such experiments, therefore, they concrete*
" *in the state of a bright red lake, whence the*
" *colour of the bones is derived.* That this is
" actually the case, may be shewn by a variety
" of experiments. Thus, if to an infusion of
" madder in distilled water, be added a little
" of the muriate of lime, no change is per-
" ceived: but if to this mixture be added a
" solution of the phosphate of soda, imme-
" diately a double elective attraction takes

" place. The muriatic acid combining with " the soda, remains suspended, or dissolved " in the water; whilst the phosphoric acid, " thus deprived of its soda, combines with the " lime, which the muriatic acid parted with, " and forms phosphate of lime or earth of " bones. This substance, however, being in- " soluble in water falls to the bottom; but " having combined at the instant of its forma- " tion, with the colouring matter of the " madder, they fall down united into a crim- " son lake; precisely of the same tint with " that of the bones of young animals, which " have been fed with madder. From this " simple representation of the matter, we have " a ready explication of every circumstance, " which has been remarked as extraordinary " respecting this subject."

Whilst Dr. Rutherford thus gives a most satisfactory explanation of the colour of madder being communicated to the bones alone, of all the white parts of an animal; we find that he embraces the same opinion, as other physiologists; that the osseous materials acquire their colour previous to their deposition, whilst in a state of solution or mixture in the blood; from whence they are afterwards deposited, and concrete in the form of a bright lake. In no part of his ingenious remarks does he hint at

the probability, that the bones, already formed in an animal, may, during the use of madder, become red, and after its disuse gradually resume their natural colour, by the agency of a power entirely independent of their deposition and absorption; That this is probable I shall now proceed to prove.

Before it was discovered that madder possessed this property of tinging bones, physiologists had long been of opinion, that the various parts of the body, being worn out by the performance of their actions and functions, were gradually removed, and replaced by new materials. They had seen, as Mr. J. Bell observes, the whole osseous system by the morbid removal of its solid part, rendered so soft and flexible as to bend under the common weight of the body and ordinary action of parts; the regeneration of many bones which had been destroyed by disease; the rapid absorption of fat in some diseases, and its speedy reproduction; and lastly, the gradual change which the fluids of the body undergo, as well as some of its insensible parts, the hair and nails; hence they supposed that the same process of change and renovation went on in every organ, and that the bodies of animals were not composed of the same identical particles, of which they would consist at some

future period. This process, which was before but conjectural, or supported by analogy, physiologists considered as fully proved by the effects of madder upon the bones. They had by this means an opportunity of seeing the bones altered in colour, from the slightest tint to the deepest red; they could observe this gradually removed, until the bones had regained their natural whiteness; and explaining the whole process on the principle of deposition and absorption, they considered it as ocular demonstration of a most rapid change in the constituent elements of a part, of which, from its solidity, they could scarely have believed it susceptible.

I apprehend, however, that it is by giving an erroneous explanation of the phenomena; by supposing that a change in the osseous particles is denoted by an alteration in their colour, that physiologists have considered this fact as conclusive. However indubitable and well supported may be the opinion, which attributes an imperceptible change to the various parts of the body, we shall, I believe, discover upon a more close examination, that it is by no means supported by the appearances, which the bones display on the exhibition of madder root. The rapid change in their particles, which such ap-

pearances indicate, when explained in the common way; is completely at variance with all the processes performed by the bones, both in their healthy and diseased states. Thus we find the formation of the ossific matter, called Callus, for the union of fractured bones; or the exfoliation of a part of a bone, are processes requiring a considerable length of time for their performance. In Dr. M'Donald's experiments, the formation of a regenerated bone required nearly six weeks; but during the same space of time, the bones of the same animal would be renewed several times, if the common explanation of the communication and disappearance of the tinge of madder were well founded. From these circumstances, I am led to believe, that the appearances produced by the exhibition of madder, require another mode of explanation. That which I have to offer is not liable to the same objections, and is strongly supported by comparative experiments.

It was observed by Du Hamel, in his experiments, that the bones of animals, which had been deeply tinged by madder, by long exposure to air lost their colour and became white. It was this fact which suggested to me a simple explanation of the process. It occurred to me, that if any one of the component parts

of the blood naturally exerted a stronger attraction for the colouring matter of madder, than the phosphate of lime, it might be deprived of the tint by a chemical power. In order to prove this, as far as I could by experiment, I took one dram of the phosphate of lime tinged, as in Dr. Rutherford's experiment, and exposed it for half an hour to the action of two ounces of fresh serum, at the temperature of 98 degrees. By this operation, the serum gradually acquired a red tinge, whilst the phosphate of lime, was proportionably deprived of colour. In a comparative experiment, a similar quantity of tinged phosphate of lime, was exposed to the action of distilled water under similar circumstances; but no change took place. The knowledge of this strong affinity, in the serum for colouring matter, affords an easy and simple explanation of the effects of madder on the bones, upon the principle of chemical attraction.

Thus, when an animal has madder mixed with its food, the blood becomes highly charged with it, and imparts the superabundant colouring matter to the phosphate of lime, contained in the bones already formed; as it circulates through them and moistens them throughout. But as soon as an animal has ceased to receive the madder, and the blood

is freed from the colouring matter by the excretions, the serum then exerts its superior attraction, and by degrees entirely abstracts it from the phosphate of lime, and the bones resume their natural whiteness. In short, the bones are at one time dyed by the colouring matter, at another time bleached by the serum.

Whilst I have attempted to explain the probable manner in which the bones, *already formed* in an animal, at one time receive, and at another are deprived of the colouring matter of madder, I by no means intend to assert; that the phosphate of lime does not acquire a similar colour during its solution in the serum, or at the time it is precipitated from it to enter into the composition of the bones; the fact is indisputable. I have, however, found from some experiments lately made upon a hen during oviparation, that only a slight tinge can be communicated to the shell, formed whilst a large quantity of colouring matter is circulating with the blood. So slight indeed is the blush, that it would not be seen by a common observer, unless contrasted with a natural egg: which is probably the reason why it has, I believe, been denied by physiologists, that the shell of the egg is altered by the exhibition of madder. If this may be con-

sidered as a test of the quantity of colouring matter, which the phosphate attracts at the time it is separated from the blood, it forms another strong argument against the theory, which Dr. Rutherford, and all preceding physiologists have adopted; for, consistent with this fact, the bones should never exhibit more than a slight blush. When explained upon the principle of chemical attraction, we see that the phenomena, exhibited by the bones of an animal, by giving or withholding madder root, give no support to the opinion that the various parts of the body continually undergo an imperceptible change; and I consider it a fortunate circumstance for that doctrine, that so simple an explanation of the effect of madder can be given. For whilst so specious a fact has been considered, by the highest authorities, as complete proof of the imperceptible renovation of parts; the rapid change in the constituent elements of the bones, which the communication and disappearance of the colour indicates, must have appeared astonishing to every physiologist. Of this I cannot give you a stronger instance than in the words of Mr. J. Bell,* "Nothing," says he, "can be more curious "than this continual renovation and change

* Anatomy of the bones, &c. p. 13.

" of parts even in the hardest bones. We are " accustomed to say of the whole body, that it " is daily changed; that the older particles " are removed, and new ones supply their " place; that the body is not now the same " individual body, that it was; but it could " not be easily believed that we speak only " by guess concerning the softer parts, which " we know for certain of the bones.—When " madder is given to animals, withheld for " some time and then given again, the colour " appears in their bones, is removed, and ap- " pears again with such a sudden change, as " proves a rapidity of deposition and absorption " exceeding all likelihood or belief; all the " bones are tinged in twenty-four hours; in " two or three days their colour is very deep, " and if the madder be left off but for a few " days, the red colour is entirely removed."

Although by this chemical explanation of the effect of madder upon the bones, the doctrine of the imperceptible change in the component parts of animal bodies, loses the support of a fact, which has, since its discovery, been universally considered as its strongest proof; nevertheless, indisputable arguments, derived from different sources, still place that doctrine amongst the best supported opinions in physiology.

On the USE *and* ABUSE *of* POPULAR SPORTS *and* EXERCISES, *resembling those of the Greeks and Romans, as a National Object.*

By SAMUEL ARGENT BARDSLEY, M. D.

Read March 19th, 1802.

HUMAN nature is so constituted as to require both bodily and mental recreation. This instinctive propensity to amusement in man, is sufficiently proved by the universality of the appetite, in every stage of life, under every variety of clime, and constitution of government. But the regulation of this natural propensity differs greatly according to the circumstances under which he is placed. The recreations and sports of mankind are therefore diversified by the influence of moral, political and physical causes. The means of gratification are various and complex: the end simple and uniform. To escape from the sensations which may be induced by too great or too little exertion of body or mind, and to enjoy the pleasure which sympathy extracts from the varied intercourse with fellow man, give rise

to that fondness for public diversions and sportive contests, so conspicuously displayed in the history of mankind.—The influence of physical causes, in regulating the nature of these diversions, may be readily conceived.

The hardy, strenuous and active amusements of the inhabitants of the temperate and frigid zones, would depress and exhaust, rather than enliven and invigorate, the residents of a torrid clime. Hence the supreme delight of the Asiatic consists in the enjoyment of those pleasures which are purchased with little fatigue of body, or agitation of mind. To inhale the grateful fumes of his pipe, and to foil his adversary in the stratagems of chess, or other sedentary games, constitute the principal part of his amusements.

Although physical causes necessarily circumscribe the sphere of man's active pursuits, yet they have much less controul than those of a moral and political kind. Man is endued above all other animals with a frame and constitution which can adapt itself to every diversity of clime and change of temperature. He can, in a measure, subdue physical obstacles, when powerfully stimulated by moral and political causes.—The savage, compelled to hunt his prey for food, has little leisure to cultivate his intellectual taste and powers.—If not exposed

to danger from hostile neighbours, his recreations are mostly of a negative kind.—He is happy when idle and at ease. But if he be stimulated by the prospect of war, all his amusements tend to accomplish him for carrying on successfully his military exploits. His songs are praises of the heroes of his nation; and his dances are connected with martial discipline. The public shews and festivals of his country are, almost without exception, of the character of savage war.*

According to the degree of civilization will the public sports and amusements of a people partake more or less of the mixed character of corporeal and mental recreation. A display of the arts which refine and gladden life, can only flourish where the condition of man has been long meliorated by the enjoyment of moral and political advantages.—

* The savage tribes of America furnish various proofs of the truth of this remark.——Likewise in Collins's account of the natives of New Holland, there is a curious illustration of the propensity of a rude and savage people to those amusements which are adapted to their peculiar situation.

Indeed the singular and ludicrous ceremony of initiating youth into the rank of warriors, at the celebration of their military exercises and games, is a striking instance of that disposition to amusement, which even the most savage and wretched state of life cannot eradicate.

Indeed the kind and nature of the popular sports and exhibitions of a people, whether just emerging from barbarism, or passing through the various stages of improvement, or arrived at the highest pitch of refinement, serve to measure, as by a scale, the different degrees of their advancement to the acme of civilization. The two most powerful and celebrated nations of antiquity, Greece and Rome, afford ample proofs of the truth of this remark. The shews and public sports of each of these nations, while they issued from their character and manners, operated on this very character and manners, and rendered them more ardent and permanent. This connection between the character of a people and their sports, was forcibly impressed on their legislators and rulers. Their public games were instituted for other purposes than mere amusement and relaxation. They were rendered subservient in Greece to the noblest views of legislative policy. Intimately connected with the whole system of government, whether civil, military, or religious, they had a moral as well as a political tendency. To promote ardor, emulation, friendship, patriotism and all the animated principles and connections of active life, the Olympic, and other solemn festivals, were in-

stituted. In order to investigate some of the moral and political effects of these popular sports and public games, which contributed so largely in raising the Greeks and Romans to a height of unparalleled grandeur, it will be necessary to examine the foundation of a system, which, in some respects, when freed from its worse abuses, particularly those which the more ferocious character of Rome introduced, may not illaudably nor unusefully be imitated by the most civilized nations.

Though it may, perhaps, be admitted, that the difference in the state of knowledge and general policy, in the ancient and modern world, will not admit of a close approximation in the system of their public sports and amusements; yet the principles to which the Greeks directed their attention in controuling popular amusements, deserve the limited imitation of every free and enlightened people. For, their aim was to direct to innocent and useful objects, two of the most powerful principles of the human breast;—the love of pleasure and the love of action. Hence arose the institution of the * gymnastic exercises, which formed the

* Lycon, according to Pliny, first instituted the gymnastic games in Arcadia, whence they were extended throughout Greece and successively contributed to the

principal part of all the solemn games. The gymnastic art consisted in the performance of bodily exercises calculated for defence, health and diversion. That branch of these exercises, called the athletic or sportive, must be considered as coeval with the formation of society.* The five † gymnic exercises, so accurately described by Homer, Pindar, Sophocles, and Pausanias, formed the principal branch of the education of youth.

To be enabled to excel in the performance of these, they were trained with the greatest

highest gratification of both the Greeks and Romans, in their private schools and public solemnities.

They were performed in the *Gymnasium*, where not only youth were instructed in these exercises, but also the philosophers taught their different doctrines.—The *Palæstra*, which formed a part of the building, was the school for the gymnic exercises.

*. In almost every island of the great Pacific Ocean, we find a similarity, more or less striking, in the athletic and warlike exercises of the natives, with those practised in Greece.

† These five exercises were called Pentathlum by the Greeks, and Quinquertium by the Romans. They consisted of leaping, running, throwing the Discus, darting the javelin, and wrestling; but instead of darting the javelin, others mention boxing. The last exercise was combined with wrestling; and then took the name of Pancratium.——See Hieronymus Mercurialis, de arte gymnasticâ—and Potter's Archæologia.

care; and every means was employed to excite powerful emulation. Their object was, to recreate and strengthen the body, as well as fortify and exalt the mind. For, the firm organization acquired by perpetual exercise, counteracted the propensity to vicious indulgence, which a voluptuous climate naturally inspires.

They likewise infused a courage depending on animal strength and vigour, which was excited to the highest pitch among this warlike people.* Besides, the ambition of honest fame (the sure † reward of excellence in these sports and contests) taught them to controul the appetites of the body by the affections of the soul.

But the chief aim and end of the institution of athletic gymnastics among the more warlike states of Greece, were, perfection in the military character. Their philosophers inculcated this doctrine by their precepts and example.—Plato, in his book of laws, after having viewed

* Hac arte, Pollux & vagus Hercules
Innixus, arces attigit igneas.—HOR.
"Thus mounted to the towers above,
"The vagrant hero, son of Jove."

† Such as gained victories in any of these games, especially the olympic, were universally honoured, and almost adored.——See Plutarch's Sympos. lib. 11. Quest. VI. and Potter's Archæol.

the high importance of acquiring bodily force and agility, adds, " a well governed common wealth, instead of prohibiting the profession of the athletic, should, on the contrary, propose prizes for all who excel in those exercises, which tend to encourage the military art."—And, perhaps no better plan could have been contrived to foster a warlike spirit amongst a people devoted to military enterprize, than the training of youth in these hardy and laborious exercises, and in proclaiming rewards for those who excelled in their public exhibition. If man were only destined to conquer and triumph over the weaker and less valiant of his race—if the lust of dominion were the only appetite worthy of gratification, then the cultivation of bodily prowess and ferocious courage would properly form the business, as well as pleasure of life. But man has a nobler part to act in society;—and enjoyments more pure, lasting, and better fitted to the dignity and character of his nature, become necessary to his well being in an advanced stage of civilization.—It may readily be conceived, that those arts which sooth and embellish human existence, and which depend on the cultivation of feeling and of taste, would be neglected by the Greeks, when only bodily strength, activity and address could carry off the palm of

victory. In the distracted state of the first settlers in Greece, when the bodily energies were constantly in action, courage and personal strength decided the day in most of their military conflicts. Hence courage became associated with every idea of patriotism, honour, and virtue. It is the opinion of Aristotle, "That the nations, most attentive to the formation of the body, strive to give it too athletic a habit, which injures the beauty of the shape, and stints the growth of the person. The Lacedemonians avoid this error; yet, by imposing excessive labour on the body, they engender ferocity in the mind, thinking this conducive to martial spirit. But mere warlike courage, taken separately by itself, is a doubtful and defective quality, and, cultivated too assiduously by the hardening discipline of toils and struggles, will degrade and debase the *man*, blunt his faculties, narrow his soul, and render him as bad a soldier as he is a contemptible citizen."* This necessity of rendering the gymnastic art subservient to nobler pursuits, was felt and acted upon by the Athenians, and other polished states of Greece.

The cultivation of poetry and music was encouraged by bestowing the highest honours

* Gillies's Aristot. polit. p. 250.

and rewards on those who excelled in these delightful arts at the celebration of all the public games. To such a happy combination of mental with corporeal excellencies, cherished and displayed under the most pompous and fascinating appearances in their popular diversions and solemn festivals, may the splendid achievements of this distinguished people be attributed.* Considered in the light of affording amusement, exciting generous emulation, and of creating robust and hardy citizens, endowed with energy to resist slavery

b

* Montesquieu is of opinion, that the want of employment for the majority of the citizens, compelled the Greeks to become a society of athletic and military combatants; for, he observes, "they were not permitted to follow the ordinary occupations of agriculture, commerce, and the baser arts; and they were forbidden to be idle; consequently, their only resource was in the gymnastic and military exercises."—But this assertion is contradicted by the practice of some of the Grecian states. We know that in Athens commerce was highly esteemed and successfully cultivated. This writer must therefore be understood in a restrictive and qualified sense, when he says, "Il faut donc regarder les Grecs comme une société d'athletes & des combattans."—Montesquieu de l'esprit de loix. liv. IV. chap. VIII.

The Pancratium, in which the antagonists voluntarily threw themselves on the ground, and annoyed each other by pinching, biting, scratching and every kind of savage attack, ought not to be endured in a civilized country.

at home, and enemies from abroad, the gymnastic exercises, with some exceptions, and under proper regulations, are worthy of the admiration and imitation of all free and civilized states. But there was another kind of popular sport, common to the less polished states of Greece, and which has been practised by mankind, not only in the rude and barbarous, but (to the disgrace of humanity) in the most advanced and polished period of civilized life. This amusement depended on the contests of ferocious animals, whose natural antipathies were made use of, and designedly enflamed to gratify a depraved and barbarous taste.—"They delight," says Lucian, (speaking of the Greeks,) "to behold the combats of bold and generous animals, and their own contentions are still more animated."—The savage ferocity inspired by the frequent repetition of such barbarous exhibitions, accounts in some measure for the conduct of the Ephori of Sparta, who, when they declared war against the Helots, ordered that the young bull-dogs should be employed in worrying these miserable slaves. To the Greeks may be attributed two barbarous diversions which have been eagerly adopted by succeeding nations. The fighting of cocks, and the diversion of bull-fights. The former was first

introduced by Themistocles, as a religious festival:—it soon degenerated into a sport for the gratification of avarice and cruelty. The latter had its rise in Thessaly, and was afterwards transported to Rome by Julius Cæsar.*

To Greece, Rome was indebted for almost every institution of popular sports and bodily exercises;—but the Romans carried them to a height of splendour and magnificence unknown to their first inventors. The Circus and Amphitheatre of Rome, exhibited, on a scale proportioned to the immense extent and power of the nation, all the popular sports† celebrated at Grecian solemnities. In their gymnasia, youth were likewise carefully instructed in the gymnic exercises, and likewise the athletic combatants trained up for public exhibition:—But the barbarous policy of the state, or rather the rude and ferocious manners

* See Pegge's Dissertation on Cock-fighting in the Archœologia—Brittan and Potter's Antiquities of Greece.

† The Ludi circenses, or circensian games, included all the diversions of the Circus, viz.—The Pentathlum, or Quinquertium, chariot races, Pyrrhic dance of the Greeks, to which were added sports of Roman origin.—The Naumachia, or sea fights, and bloody combats of gladiators, and the contests of ferocious animals with each other and with man.

of the people, gave rise to the alliance of bloody shews and combats, with manly sports and exercises. A gloomy and ferocious superstition, operating on the minds of a people inured, like the Romans, to foreign warfare and intestine broils, suggested the practice of shedding the blood of captives, as a grateful sacrifice to the *manes* of illustrious warriors.—This practice, at first a superstitious rite, became a ceremony of more pomp and ostentation at the obsequies * of distinguished persons. Hence the origin amongst the Romans of the profession of a gladiator—and when the people had once acquired a taste for bloody exhibitions, the detestable spectacle of gladiatorial combats was presented for their amusement.

The progress of cruelty and the danger of gratifying barbarous propensities, cannot admit of more striking illustration than what is afforded by considering the effects of these savage exhibitions on the manners and character of the Romans.

This is not the proper place to discuss the question, of *Right* or *Expediency*, which man

* The first shew of gladiators was instituted by Marcus and Decius Brutus, on the death of their father, in the year of the city, 490.——See Kennet's Antiquities of Rome.

has always claimed of rendering subservient to his wanton sports, the lives and feelings of the brute creation. It will come with more propriety under discussion in the sequel of these observations.—But it may not be improper, at present, to animadvert on the consequences of rendering bloody scenes familiar and amusing to even an enlightened people.

The frequent spectacle of * animals conflicting with each other in the games of the amphitheatre, gradually hardened the public mind, and begat a necessity for diversions of a more animated and dangerous kind.—Men were encouraged, and even compelled to enter the lists with wild beasts. At first, condemned criminals forfeited their lives in these contests. But these were not sufficiently numerous to gratify the appetite of a degraded

* In the shew of wild beasts exhibited by Julius Cæsar in his third Consulship, twenty elephants were opposed to 500 footmen, and 20 more with turrets on their backs (sixty men being allowed to each turret) engaged with 600 foot and as many horse. There were three sorts of these diversions, under the common title of Venation. The first, when the people were permitted to run after the beasts and catch what they could for their own use—the second, when the beasts fought with one another; and the third, when they were brought out to engage with men.——See Kennet's Roman Antiquities.

and licentious people. Men* were professedly instructed and regularly hired to sell their blood, like gladiators, in these bestial contests. Such enormities, great as they are, hide their diminished heads, before the supreme wickedness and cruelty of *gladiatorial* exhibitions.—When the susceptibility to humane and tender feelings became almost extinct by the bestial encounters, it became necessary to gratify their depraved appetites by the exhibition of human butchery and sacrifice. So lost to every spark of decency and humanity were this infatuated and ferocious people, that the highest ranks of society gloried in voluntarily taking a part in these encounters:—and even the softer sex, throwing aside every trait of amiable modesty and timidity, were ambitious of displaying their personal courage in these savage contests. This conduct did not escape the lash of the Roman satyrist.

"Cum———Mævia Tuscum,"
Figat aprum, & nuda teneat venabula mamma."
"Or, when with naked breast the mannish whore,
"Shakes the broad spear against the Tuscan boar."

Persons of every age, sex and condition attended these barbarous sports. The intoxication of the populace, from frequent gratifica-

* These were called Bestiarii.

tion, arose to such a pitch, that streams of blood flowed annually from several hundreds, perhaps thousands, of the wretched gladiators, throughout the various cities of the empire.—When the people had been so far steeped in blood as to prefer beyond any other these sanguinary combats, all the candidates for high offices bribed their favour, by outvying each* other in the number and pomp of these impious shews. Even the most powerful and enlightened minds among the Romans were tainted by the contagious influence of custom and the strength of national prejudice: Cicero, the humane and dignified statesman and philosopher, very faintly, if at all, disapproves of the excessive fondness of the people for this abominable exhibition in his time; and plainly expresses his approbation of the practice as antiently conducted. His words are, "crudele gladiatorum spectaculum & inhumanum nonnullis videri solet; & haud scio an ita sit, ut

* Julius Cæsar, in his Edileship, presented three hundred and twenty pair of gladiators—and Trajan, as averse from cruelty as the former, brought out 1000 pair of gladiators during a solemnity of 123 days.—But the sanguinary hero, enlisted 400 senators and 600 knights (if there be not a corruption of the text of Suetonius, the historian) as gladiators, at a celebration of the Circensian games.—See Gibbon's History of the Decline and Fall of the Roman Empire.

nunc fit: cum verò sontes ferro depugnabant, auribus fortasse multæ, oculis quidem nulla poterat esse fortior contra dolorem & mortem disciplina."—"The shews of gladiators to some persons may seem barbarous and inhuman: and I don't know as the case now stands that the censure is unjust:—But when only guilty persons were the combatants, the ear might receive better instruction—it is impossible, however, that any lesson to the eye can better fortify the mind against the assaults of grief and death." A ridiculous and inhuman assertion (an eloquent historian exclaims) admirably confuted by the bravery of ancient Greece and modern Europe.

Indeed so little was the practice connected with military ardour and true courage, that before its establishment the Romans were, perhaps, more distinguished for bravery, steadiness of discipline and contempt of death, than at any subsequent period of their history.

It is, however, certain, that in proportion to the frequency and extent of these bloody exhibitions, did the military valour and discipline of the Romans sink into a state of degradation and contempt.—"After subsisting a period of 600 years" (according to the remark of Gibbon), "Honorius gave the final blow to this inveterate abuse, which de-

graded a civilized nation below the condition of savage cannibals."

Rome justly suffered moral and political evils from fostering such inhuman propensities: Her existence was more than once at stake by the insurrection of the wretched and despairing victims of her barbarity. Besides, the corruption of the populace, through the medium of these diversions, was no difficult task to the powerful and wealthy. When man has been taught to subdue the humane feelings of his nature, he contracts an indifference to the purer and nobler virtues which fit him for discharging the duties of a good citizen. Indeed every habit that wears out the sympathizing sensibility of the heart, proportionably disqualifies man from exercising the pleasing duties and tender charities, connected with public and domestic life.

It would appear from this hasty sketch that the popular games and exercises of the Greeks when compared with those of the Romans, were better calculated to promote the social as well as individual welfare of mankind. The Grecian sports fortified the body and disciplined the mind, without injuring the one or brutalizing the other.

Indeed the superior wisdom of Grecian policy rendered the public diversions subser-

vient to the interests of the state as well as to the happiness of the people. The Roman government did not always neglect this branch of policy. For, their sports, in the early and rude state of the nation, were adapted to the circumstances in which the people were placed. But incessantly harassed themselves, or employed in harassing others, they had neither leisure nor inclination to cultivate those arts which contribute to liberal amusement: Ever occupied with warfare, all their amusements had a warlike tendency. The contests of savage animals and the conflicts of gladiators, suited alike the ferocious manners of the populace and the political views of their rulers. When the empire had subdued more polished nations, it might have been expected, that its amusements would have assumed a different spirit and complexion.—But the habits of the people were too deeply rooted and depraved to be easily changed—And, indeed, so far were their rulers from wishing to accomplish this reformation, that from corrupt and selfish views, they studiously excited the propensities of the people towards degrading and inhuman shews, by administering constant food for these savage enjoyments.

In the progress of civilization, since the downfal of the Roman empire, great and im-

portant changes have taken place in Europe, with respect to religious, political and civil institutions. The melioration of the condition of man in his social and domestic state, and the general refinement of his character and manners, have been the happy result of these moral and political revolutions. Yet still there remain sufficient vestiges of antient barbarity to throw a dark shade on the present state of improved civilization. The cruel sports still so highly relished in many parts of modern Europe, and which bear so near a resemblance to the savage contests of the Circus, exhibit lasting and disgraceful proofs of the relics of antient barbarism. Our own country has been but too justly stigmatized, even by her less polished neighbours, for the devotion of the lower ranks of the people to those amusements which are derived from the sufferings of the brute creation.

Although the resemblance (whether it be original or imitative is of little importance) between the cruel diversions of England and of Rome, may be considered a subject of just regret; yet the similarity in some of the manly exercises and hardy sports, practised by the two nations, cannot but claim our warm and just admiration.

If we have retained more of the barbarous

sports of antiquity than the rest of Europe, there is the merit due to us of having more extensively adopted and practised those amusements and exercises, which inure the body to labour and fatigue, and inspire the mind with courage and emulation. In treating on the general character and spirit of some of the sports and exercises of the people of England, it will not be necessary to enter into particular detail. It is only proposed to hint at those of a popular nature, and which seem to be interwoven with the customs and manners of the mass of the people. They may be comprised under two heads.

1st. The sports which are derived from the animal creation.

2d. The amusements which depend upon bodily exercises and personal contests.

I. It cannot be denied, that mankind, at every period of society and under every diversity of country and government, have rendered the animal race subservient to their wanton and cruel sports. But the universality and antiquity of a practice, founded on inhumanity and impolicy, are inadequate to sanction its utility and continuance. If it can be shewn that barbarous sports tend to brutalize the human character, and are inconsistent with the manifest intentions of providence; the argument

derived from long custom and authority must fall to the ground. There is a sympathy implanted in our natures, which renders us feelingly alive to the pains and pleasures of our fellow-creatures, and is even extended to every part of the animal creation. Upon the due exercise of this principle depends great part of our social and individual happiness.—— Whatever then has a tendency to diminish the influence of this principle, ought carefully to be avoided. Now every single act of cruelty contributes its share towards the weakening or extinguishing the principle of sympathy; and by the repetition of such acts, according to the general laws of habit, * a disposition to cruelty is likely to be generated. If a child be early indulged in sportively tormenting *animals*, and this vicious propensity be suffered to grow up into a habit, his sensibility to *human* suffering will be proportionably diminished;—insensibility will harden into brutality; and at length he will not be restrained

* "The habitude which the people of this country (viz. Cape of Good Hope) necessarily acquire in witnessing instances of cruelty on human as well as brute creatures, cannot fail to produce a tendency to hardness of heart, and to stifle feelings of tenderness and benevolence. In fact, the rigour of justice is seldom softened with the balm of mercy."——See Barrow's Travels in Africa, Vol. 2. p. 41.

from positive acts of cruelty towards his own species, whenever goaded by the feelings of interest or of passion.—Hogarth, our great moral painter, has admirably illustrated the progress of cruelty in the human breast. The first stage of his Hero's career is marked by sportive and wanton barbarity to animals.—Upon this foundation crimes are soon erected; and at length grown callous to every social* and moral feeling, he closes his profligate career, by the perpetration of a deliberate and cruel murder. Another excellent judge of the human heart, Dr. Moore, has forcibly de-

* Such is the general impression on the mind of the power of habit to generate cruelty, that in most countries, those occupations which employ men in the destruction of animal life for the sustenance of human kind, are held in degradation and contempt. The lowest of the butchering tribe, in default of an executioner, is compelled to perform his functions in France and many other parts of the continent. There is an opinion prevailing in England, that butchers, and even surgeons, are equally disqualified, by the nature of their occupations, to sit upon juries, in trials affecting the lives of their fellow-subjects. This is probably a popular error; or, if true, yet a much more honourable reason may be assigned, why surgeons are not required to act in the capacity of jurors. Their office is to administer to the sufferings and calamities of their fellow-creatures—and it is fit they should every moment be disengaged and free to obey the summons to so humane a duty.

picted the effects of wanton cruelty to the inferior creation, in the character of Zeluco.—The feelings of humanity became stifled in this monster's breast, from an early gratification of his caprice and passion in sporting with the torments of the animal race. It is likewise our *duty* as well as moral advantage—to refrain from all acts of wanton cruelty to the brute creation. The organs of sensation in all the inferior animals, are evidently adapted for receiving and transmitting impressions of pain and pleasure,—and although deprived of speech, their groans and cries are intelligible indications of their painful feelings. Nor are animals less capable of expressing signs of pleasure as well as of suffering. This provision for the gratification of their several senses, is a sufficient proof of the intentions of the Creator. Like man, they were formed to feel and to enjoy. Here rests the foundation of their natural right to protection and humane treatment from mankind.

It cannot be inferred from this mode of reasoning, that animal life should in every instance be held sacred. The laws of nature and necessity demand from us the painful sacrifice.—Man must destroy life in order to live. Besides, we must consider that if man had subsisted only on vegetable food, the majority of the animal race which furnish his table would

never have enjoyed life. Instead of increasing the breed of animals, he would have been compelled to destroy them to prevent a famine.—But barbarously, wantonly and deliberately, to torture and destroy animal life, is equally repugnant to humanity, duty and the best interests of mankind. Experience teaches us, that the common sense and feeling of mankind, condemn that man whose greatest delight seems to consist in bloody and barbarous sports.—Youth, it must be observed, commonly inflict pain on animals in mere sport, without a due knowledge of the evil they commit. And the ignorant populace frequently err from the same cause. They are led to consider, but too often, from the connivance and even encouragement of their superiors in knowledge and station, that the animal race are equally indifferent to pleasure or pain; and only created for the purpose of gratifying the appetite, or contributing to the diversion of mankind.

If the question be asked,—"Whether all sports derived from animal suffering be entitled to equal condemnation?" The answer is decidedly in the negative.—For, although perhaps none can be completely justified, yet there is still a wide difference in the degree of moral and physical evil resulting from their practice. That class of diversions pursued for

the benefit of health and exercise, where the enjoyment of pleasure springs from the exertion of our active faculties, must not be compared with those depraved and cruel sports, which merely consist in the torture and destruction of the animal. In the present state of society, active diversions become almost necessary to the well being of the opulent and sedentary classes of mankind. Man cannot be happy without occasional active employment. He pines in the lap of ease and pleasure, and requires the stimulus of animated exertion.—Hunting in all stages of society, has therefore formed a principal share of the business and pleasure of man. But in this kingdom especially, a considerable portion of its inhabitants devote part of their time to the active and vigorous pursuits of the chace. And although it may be urged in favour of this exercise, that it invigorates the spirits, teaches men to despise enervating pleasure, and inures them patiently to sustain hunger, cold and fatigue; yet it cannot be denied, that it has a tendency, when too eagerly pursued, to blunt the sensibility,—to render the manners rude and coarse, and thus to degrade the dignity of the human character. The man of enlarged understanding, liberal notions and elegant manners, may occasionally call in the aid of the chace to re-

lieve the fatigue of sedentary employment, or renovate the powers of nature, exhausted by mental exertion, without much apparent injury to his manners or morals ;—but *frequently* to take pleasure in that, by which misery to animals is inflicted, if not absolutely vicious, is yet of no good tendency; it conduces neither to form the gentleman nor the man. If it be considered as too nice and fastidious a delicacy to impute blame to the practice of destroying animals for the purpose of health, exercise and recreation, it may, however, be allowed to call in question the policy and humanity of other diversions, once highly cherished, and still too much practised by the people of this country. Some of these national sports are sanctioned by the practice and encouragement of many persons distinguished for rank and talents.—That there should be found such abettors of the bloody and barbarous diversions of *cock-fighting* and *bull-baiting*, is both a subject for surprize and regret.—These two amusements seem to have survived the destruction of many other sports equally as unmeaning and barbarous; but that they should not have entirely yielded to the improved state of manners—or the interference of the laws, is a subject of just reproach to us by foreigners, and of deserved reprobation by the humane and reflecting of

our own countrymen. The reciprocal influence of sports and manners on each other, may be shewn from these and similar diversions, as practised in various periods of our history. A late ingenious and laborious writer* has described the ancient and modern diversions of the people of Great Britain, from the earliest authentic records to the present time.—This picture confirms the general truth of the position:—That as a nation improves in manners and civilization, it loses its high relish for inhuman and ferocious diversions. It is more than probable, that the sports derived from animal contests, such as bull-baiting, bear-baiting, and cock-fighting, are vestiges of Roman amusements introduced by that people into this conquered island. It is at least certain they were practised † in the early

* See Strutt's Diversions and Pastimes of the People of England.

† The Jongleurs or Jugglers, in the reign of Henry the 2d made a profession of training bulls, bears, and even *horses*, for the purpose of baiting them with dogs.—The sport of fighting cocks in pitched battles, first appears on record in the same reign. During subsequent reigns this sport became general; and, to the disgrace of our country, was countenanced by royal favour during James the 1st and Charles the 2nd's reign. If the Romans set us the example in devising these sports, it must be confessed, we have "bettered the instruction." For

period of our history. During the military enthusiasm of the middle ages, while jousts and tournaments furnished amusement to the nobility and gentry, martial exercises constituted the chief diversions of the body of the people. Hence arose the establishment of schools for teaching the "Noble science of defence," as it was called. These laid the foundation for professed gladiators, or prize-fighters.—The great prevalence of murder, robbing and every species of barbarity, in consequence of these proceedings, during the reign of Edward the First, compelled the government to issue an edict to suppress the

to English refinement and ingenuity may be ascribed the noble invention of the Gaffle or Spur; by the aid of which, the gallant combatants of the cockpit mangle, torture and destroy each other; no doubt to the great satisfaction and delight of admiring spectators. Another instance of our barbarous ingenuity must not be omitted. No other nation but the British has contrived to put in practice the *Battle-Royal*, and the *Welsh-Main*.—In the former, the spectator may be gratified with the display of numbers of game-cocks, destroying each other at the same moment without order or distinction. In the latter, these courageous birds are doomed to destruction in a more regular, but not less certain manner. They fight in pairs, (suppose 16 in number) and the two last survivors are then matched against each other; so that out of 32 birds, 31 must be necessarily slaughtered.—See Pegge's Essay in the Archæologia Britannica.

schools as well as the combats of prize-fighters.

During the reign of Henry the Seventh and Henry Eighth, these schools were revived in consequence of a supposed degeneracy in the military spirit of the people; and the baiting of animals at the same time became a favourite * diversion.

The Bear-garden,† during the 16th and the early part of the 17th century, was the place of rendezvous for the highest as well as the lowest classes of society. The Tatler, when treating on the barbarous sports of this national circus, and the comments of foreigners on the subject, adds, "I wish I knew how to answer the reproaches which are cast upon us, and to excuse the death of so many inno-

* Stephen Gossen, in the latter end of Henry 8th's reign, considers that our ancestors had entirely sunk into the lap of effeminacy, as may be proved by the following singularly quaint and alliterative style of abuse. "Our wrestling at arms is turned into wallowing in ladies' laps; our courage to cowardice; our running to riot; our bows, into bowls; and our darts into dishes."

† Another common diversion, during the period of Queen Elizabeth and in the two following reigns, consisted in several persons at the same time scourging with whips a blind-folded bear round the ring, whose sufferings and awkward attempts at revenge highly gratified the noble, as well as ignoble spectators.

cent cocks, dogs, bulls and bears, as have been set together by the ears, and died an untimely death only to create us sport." Bull-baiting was not confined within the limits of a bear-garden, but was universally practised, on various occasions, in all the towns and villages throughout the kingdom. In many places the practice was sanctioned by law, and the bull-rings affixed to large stones driven into the earth remain to this day, as memorials of this legalized species of barbarity. The regular system of bull-baiting seems to have commenced with the reign of King John. Its general prevalence since that period, until within a few years, must have produced important effects on the manners and character of the people. The misery it has inflicted on the harmless and inoffensive brute, is a matter of no small regret and indignation with the humane and considerate part of mankind;—but the injury done to public morals and social happiness, by an attachment to this degrading pastime is still more to be deplored. Numbers of bulls were, and still continue to be, regularly trained and carried about from village to village, to enter the lists against dogs bred up for the purpose of the combat. To detail all the barbarities committed in these encounters would be a disgusting and tedious task. All

the bad passions which spring up in ignorant and depraved minds are here set afloat. The torments and blood of the suffering beast are purchased by money of his unfeeling master; and the owners of the dogs are not more gratified in gaining their sanguinary wagers, than in applauding the savage ferocity displayed by these animals. We cannot often appeal to the annals of bull-baiting;—but if they were regularly laid open, it is probable that many instances of a similar kind to the following might be held up as a lesson to the abettors of such diversions.—* "Some years ago at a bull-baiting in the North, a young man, confident of the courage of his dog, laid some trifling wager, that he would at separate times cut off all the four feet of his dog, and that after every amputation he would attack the bull. The cruel experiment was tried, and with success." Such detestable barbarity can only be exceeded by the following recital extracted from the public prints of 1799. At a bull-baiting in Staffordshire, after the animal had been baited by single dogs, he was attacked by numbers let loose at at once upon him.—Having escaped from his tormentors, they again fastened him to the ring; and with a view, either of gra-

* See Bewick's Quadrupeds.—Article Dog.

tifying their savage revenge, or of better securing their victim, they actually cut off his hoofs, and enjoyed the spectacle of his being worried to death on his bloody and mangled stumps. These facts speak more than a volume against the sophistic arguments of the advocates for exciting brave and manly courage by the exhibition of bloody and barbarous sports.

Although persons of rank and education, at the present period, have abandoned bear and bull-baiting to the lowest and most despicable part of the populace; and even amongst them these sports are much less frequent than formerly; yet the practice meets with countenance in some parts of the kingdom, and has been supported not long since, in one of the first assemblies of this nation, extolled by men of rank and abilities, as encouraging harmless amusement, manly spirit and contempt of danger.

These opinions appear to be so much at variance with the present enlightened, liberal and humane state of society, that to hear they have been defended by serious arguments and with persevering ardor, is sufficient to excite both regret and astonishment. Cruelty in every shape is unjustifiable;—but wanton, deliberate barbarity is dishonourable to our

nature, and contrary to the principles of natural religion, honour, justice and humanity. Of all the cruel sports, bull-baiting, as generally practised, is, perhaps, the least defensible. It is not only a cruel, but a foolish and detestable diversion. That the spectacle of two animals endowed with courage, strength and activity, exerting their antipathies to each others destruction, upon fair and equal terms, should excite our curiosity and animate our feelings, is reconcileable to the constitution and nature of man; but that any human being should delight in beholding a noble and useful animal tied to a stake, and deprived in a great measure of the means of offence and defence, and then worried and tormented by dogs and men, is a sport so insipid, so unsportsman-like,*

* Throwing at cocks is another specimen of unmeaning brutality confined solely to our own country. After being familiarized to the barbarous destruction of this courageous bird in the cock-pit, it was only advancing one step further in the progress of cruelty, to fasten this most gallant animal to a stake, in order to murder him piece-meal.——This detestable barbarity has declined as our manners have become more polished and humane; but the strong hand of the law was obliged to interfere in many places to hasten its abolition. The cruel treatment of the animal race might well lead an ingenious †

† Wenderborn, on the character and manners of the people of Great Britain.

and so cruel, as to excite wonder as well as detestation. But the advocates of these and similar cruel diversions, exclaim in a tone of triumphant interrogation—"Do not these sports inspire manly courage and contempt of danger?"—Certainly not. They are only calculated to generate cruelty and a thirst for blood. They may, indeed, inspire ferocity and insensibility to danger, but they are unfit to impart genuine and manly fortitude.

The Romans indulged, as before remarked, in these savage diversions to a greater extent than any other nation of antiquity; yet they did not excel the Greeks, nor have surpassed the moderns, in the display of military ardour and true courage.

It is a superficial and unphilosophical view of the subject, to consider the barbarous sports of Rome contributing to the establishment of her power and military fame. These spectacles never became common till after Hannibal's defeat; and that the Romans, subsequent to

foreigner to remark, when describing our popular diversion, as follows.—"The women of Rome beheld barbarities and murders in cold blood; but the boxing-matches—the bull-baitings, cock-fightings, and the numerous attendance of both sexes at public executions, indicate that there is at least a remnant of Roman manners, and the taste of those times, left in England."

this period improved in valour and hardihood, is not recorded in the pages of their history. But may we not, with just pride, appeal to facts furnished by our own age and country? Has the valour, enterprize, or intrepidity of British soldiers and sailors shone less conspicuous, since the period that bull-baiting and other barbarous sports have declined, throughout most parts of the kingdom? The answer is recorded in the history of our late naval and military transactions.

The conduct of the Spaniards and Portugueze, when contrasted with that of our own countrymen, is a striking proof of the incompetency of savage and cruel amusements to create a courageous and warlike disposition.—Bull-fights still constitute the only active popular amusement of the two countries.—If these bloody sports were capable of inspiring active courage and manly fortitude, how are we to account for the acknowledged degeneracy of the people of Spain and Portugal in these warlike qualities?

The advocates for bull-baiting and similar sports, have recourse to another argument, or rather assertion, which they urge with great confidence: "Cruel sports," they contend, "do not necessarily generate cruelty in a people." "The English, (say they) who are

fond of these diversions, are, at the same time, less ferocious, and indeed hold the shedding of human blood more in abhorrence than any other nation on the face of the globe." Granted that we really deserve this honourable distinction—Does it follow that human nature is differently constituted in England to what it is in other parts of the world? Can it be necessary to prove, that habits of indifference to human suffering are acquired by repeated acts of cruelty to brutes; and that the sympathy of our natures must be blunted in proportion to our familiarity with scenes of unnecessary and wanton barbarity? These are almost self-evident suppositions; at least they are such inductions from daily and repeated experience, as to pass current for intuitive truths.—But if we admit that the English are more addicted to cruel sports, and yet hold human life more sacred than the people of other countries, it by no means follows, that such sports have not a tendency to create a disposition to cruelty.—How then are we to reconcile this apparent contradiction? The paradox, if there really be any, is not difficult of solution.

The life of man is always most respected, where it is of most consequence. For, in a country like Britain, where the whole body of the people enjoy political and civil rights, their

own importance, and that of their fellow-citizens will be felt and esteemed; and where just and equal laws protect the life and property of the meanest of the people, and consequently private injuries can be redressed by an appeal to the tribunals of justice, man will be less disposed to be the avenger of his own wrongs.—Besides, ignorance is commonly the parent of cruelty. Now it may be safely asserted, that the knowledge of man's duties both towards his neighbour and his Creator, are better understood and more widely diffused amongst the mass of the people in this kingdom, than in those otherwise civilized countries, where a thirst for the blood of their fellow-creatures seems chiefly to prevail. These eminent moral and political advantages are the powerful counteracting causes of that spirit of barbarism which cruel diversions are calculated to excite. If it be desirable then to efface the harsh lineaments of rudeness, and a want of feeling nearly allied to brutality, which still mar the otherwise fair visage of the national character, let all barbarous diversions be entirely olished; but especially let the sport of bull-baiting be the first offering to be sacrificed at the shrines of humanity and justice! "A diversion," to speak of it in the

language of a justly celebrated * orator, "which may be characterised as inhuman, cruel, disgraceful and beastly, and which can excite nothing but brutality, ferociousness and cowardice: For, its direct tendency is to debase the mind, deaden the feelings, and extinguish every spark of benevolence."

II. The amusements which depend on bodily exercises and personal contests.

It is not compatible with the limits of this essay to notice the variety of bodily exercises and active sports to which the people of England are generally addicted.—But there is one kind of personal contest, to the consideration of which the remaining part of these remarks will be chiefly devoted, as it has been the source of obloquy and reprobation among foreigners, to the national character. The public exhibition of boxing, and the practice of the same art in deciding private and personal quarrels, are here alluded to.

The exhibition of pugilism on a public stage, is most probably a relic of one species of the Roman gymnastic. This mode of venal stage-fighting is a barbarous prostitution of a manly and useful art, whether considered as an ex-

* Sheridan:—Parliamentary Debates on the Abolition of Bull-baiting, &c.

ercise calculated to inspire fortitude and intrepidity, or to afford efficacious means of defence against personal insult and violence. But when considered merely in the light of yielding gratification as a public spectacle, or of furnishing an opportunity for gambling speculations, it is then viewed in all its naked deformity—Yet, is not the art of boxing, by which instantaneous insult may be avenged, or personal injury averted, less dangerous than any other practice adopted by the inhabitants of the continent on similar occasions and for similar purposes?—The question is an important one; and the following facts and observations may serve, perhaps, to apologize for, if they cannot justify, a custom so interwoven with our national manners and character.

So long as man is subject to the imperfection of his nature, he must be compelled to acquire the art of self-defence, as well as that of annoyance to others. Our experience of his conduct and character, teaches us the impossibility of extinguishing the passions of pride and resentment, which, although they frequently involve him in misery, are still the sources of some of his noblest qualities and attributes.—As some portion of evil will attach to the best and wisest system of moral or civil restraint; that policy is, perhaps, the wisest,

which legislates for man as he is, not altogether as he ought to be.—Suffer the passions to reign uncontrouled, and you dissolve the bonds of society: stifle the active energies of a resolute independent spirit, and you degrade the man into a passive slave. The feeling of resentment for unprovoked injury and insult is a salutary, if not instinctive provision of our common nature. It may be asked—"Is man then to be the judge and avenger of his own wrongs? Is not every offence against the person of a citizen a breach of the laws of society? and should it not be punished as such?"——Certainly:—But if in the best regulated states, it be found impracticable to prevent man from frequently asserting a claim to the vindication of his own real or supposed wrongs, it then becomes a question of *expediency* as to the most preferable mode by which he may be enabled to obtain this end. Boxing may not unjustly be considered as the most eligible means of offence and defence. It is properly ranked among those athletic exercises, which, at the same time that they impart address and strength to the body, inspire courage and fortitude in the mind. It may indeed lead *bad* hearts and *bad* heads into acts of presumption and petty tyranny; but this propensity to an improper exertion of skill and courage would

be checked, in proportion as men were more *equally* possessed of the means of defence or aggression.—They would learn to respect the skill and bravery of each other, and consequently be less prone to undue resentment and quarrels. The government that would attempt, with a despotic and severe authority, to controul the exertions of self-confidence, and a moderate exercise of just resentment, could only expect to rule over a nation of timid and revengeful slaves. The open and ingenuous expression of manly indignation might be repressed; but the rancorous feelings of malignant revenge would be fostered and encouraged. But no state can, with any prospect of success, attempt such an absolute dominion over the passions of men. And if it did, "it must (according to the observation of a spirited author) in order to act consistently, prohibit the use of knives, hatchets, and even pokers; for any of these, upon a sudden emergency, might impart a fearful power to the enraged and the feeble."

If we consider the practice of other countries, where boxing is unknown, we shall find, that the modes of resenting injuries, resorted to by the common people, are full of danger and fe-

rocity. In * Italy, the stiletto is not only the weapon of the hired assassin, but is also kept ready in the bosom of the respectable citizen, to be plunged into the heart of his friend or neighbour, upon any sudden provocation from anger, or motive of revenge.

When the passions are under greater restraint, from the influence of laws, of climate and of custom, such dreadful consequences do not ensue from the quarrels of the populace.† Yet even in France, and most parts of Germany, the quarrels of the people are determined by a brutal appeal to force, directed in

* In an authentic publication of the life of the late Pope, it is affirmed, that upwards of 1000 persons annually fall victims in Rome to the stiletto; either by the hands of the hired assassin, or in private quarrels. Dr. Moore reckons the number of murders in Naples, by the dagger, at not less than 400 annually.

† The mode of fighting in Holland, among the seamen and others, is well known by the appellation of Snicker-Snee. In this contest sharp knives are used; and the parties frequently maim, and sometimes, destroy each other.—The government deems it necessary to tolerate this savage practice—Certain fines are imposed if wounds be inflicted on dangerous parts of the body; but a very trifling, and indeed seldom any punishment ensues, provided the general rules of the combat have been adhered to.

any manner, however perilous, to the annoyance or destruction of an adversary. Sticks, stones and every dangerous kind of weapon, are resorted to for the gratification of passion or revenge. But the most common and savage method of settling quarrels upon the continent is the adoption of the Pancratium. The parties close, and struggle to throw each other down; at the same time the teeth and nails are not unemployed. In short, they tear * each other like wild beasts, and never desist from the conflict till their strength is completely exhausted; and thus regardless of any established laws of honour which teach forbearance to a prostrate foe, their cruelty is only terminated by their inability to inflict more mischief. And yet superficial observers, and especially all foreigners who have written concerning our customs and manners, loudly brand the English

* In Virginia and the other southern states of America, the most savage acts of barbarity are committed, in the quarrels of the people. Gouching—or thrusting out the eye from the socket, is one of the means resorted to upon almost every personal dispute. An intelligent traveller, Mr. Weld, declares, that at Richmond in Virginia, it was nothing uncommon to meet with persons deprived of one or both eyes from this horrid practice.—He mentions another mode to disable an antagonist, so detestably barbarous, as to excite incredulity, if the account had not been corroborated by other writers.

character with savage rudeness and brutality, because they have seen men terminate their quarrels by an appeal to boxing;—in which the parties are not permitted to take an unfair advantage of each other, but when one is disposed to yield, the combat immediately closes, and the conqueror and the vanquished are often seen to give and receive a hearty shake of the hand, in token of mutual good will and forgiveness. In no instance does the manly, spirited and generous character of Britons, rise to a higher pitch, than in this alacrity almost universally shewn by the most ingorant and lowest order of the people, to terminate their personal contests, in a kindly and honourable manner.—The mind indeed is thus relieved at once from the brooding mischief of malice and revenge. For, when the idea of self-consequence has been maintained, in courageously supporting the contest, man is better satisfied with himself and others, and consequently more likely to dismiss his ill-will and resentments.—In order to foster manly fortitude and vigour, and to prevent the mischiefs arising from the irregular and brutal exertions of strength and ferocity—would it not be advisable to encourage the art of boxing with mufflers, as a subordinate branch of the gymnastic exercises? All *stage* exhibitions of

prize-fighting ought to be rigidly prohibited; nor should men ever be suffered to prostitute their strength and valour for the sordid purpose of gain.

It is a singular though striking fact, that in those parts of the kingdom where the generous and manly system of pugilism is least practised, and where, for the most part, all personal disputes are decided by the exertion of savage strength and ferocity—a fondness for barbarous and bloody sports is found to prevail. In some parts of Lancashire *bull-baiting* and *man-slaying* are common practices. The knowledge of pugilism as an art is, in these places, neither understood nor practised. There is no established rule of honour to save the weak from the strong, but every man's life is at the mercy of his successful antagonist. The object of each combatant in these disgraceful contests, is, to throw each other prostrate on the ground, and then with hands and feet, teeth and nails, to inflict, at random, every possible degree of injury and * torment.—This is not

* A disgusting instance of this ferocious mode of deciding quarrels, was not long since brought forward at the Manchester sessions.—It appeared in evidence, that two persons, upon some trifling dispute, at a public-house, agreed to lock themselves up in a room with the landlord and "fight it out" according to the Bolton method.—This contest lasted a long time, and was only terminated

an exaggerated statement of the barbarism still prevailing in many parts of this kingdom.—The county assizes for Lancashire afford too many convincing proofs of the increasing mischiefs arising from these savage and disgraceful combats.

The Judges, on these occasions, have frequently declared in the most solemn and impressive charges to the Grand Jury, that the number of persons indicted for murder, or manslaughter, in consequence of the bestial mode of fighting practised in this county, far exceeded that of the whole Northern † circuit;—and that, in future, they were determined to punish with the utmost rigour of the

by the loss of the greatest part of the nose and a part of an ear, belonging to one of the parties, which were actually bitten off by the other, during the fight.—The sufferer exhibited at the trial, part of the ear so torn off; and when asked by the counsel, what had become of that part of his nose which was missing—he replied—with perfect naivete—"That he believed his antagonist had swallowed it!!" It has happened to the writer of these remarks to witness, in more than one instance, the picking up in the streets, lacerated portions of ears and fingers, after these detestable and savage broils. Surely either our laws or manners might interfere in suppressing such deeds of savage barbarity!

† At one assizes, no less than nine persons were convicted of manslaughter, originating from these disgraceful encounters.

law, offenders of this description.—But, alas! these just denunciations have little availed.—Is it not then highly probable, that the evil which the severity of the law has been unable to correct, might be gradually and effectually abolished, or at least greatly mitigated, by the encouragement of a more manly, and less dangerous mode of terminating the quarrels of the populace?—In the Southern parts of this kingdom very rarely (and then chiefly in pitched battles for gain) is there any danger to life or limb from the practice of fair boxing.—If then in the public schools and large manufactories of Lancashire, where immense numbers of boys are under the entire controul of their masters and employers, some pains were taken to introduce the manly system of boxing, and the laws of honour, by which it is regulated, there can scarcely be room to doubt, but that the life of man would be more respected—barbarous propensities subdued, and the present character of the county rescued from the stigma of savage rudeness. It has been asserted, by those qualified to judge, that since the late diffusion of the knowledge of the pugilistic art by itinerant practitioners among the Northern inhabitants of this kingdom, the mere exertions of brutal strength and ferocity have somewhat fallen into disuse,

both as exercises of pastime, as well as means of offense and defence. In order therefore to abolish all traces of the savage mode of contest which has been so fully described, would it not be advisable to hold forth prizes, at wakes and public amusements, (where the populace assemble chiefly for the purpose of diversion and pastime) for the encouragement of those, who excelled in sparring with mufflers?— This trial of skill, force and agility (which was at first the practice of the antients) would contribute, *under due regulations*, to invigorate the body and animate the courage; and effectually abolish the present dangerous and inhuman method of deciding personal contests.

REVERIE;

CONSIDERED AS CONNECTED WITH LITERATURE.

AN ESSAY.

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(Read June 25, 1802.)

IT is a frequent process, and often one of the highest pleasures of the mind, to become insensible to the pursuits in which it is more immediately engaged, and yielding to impressions which lead to more interesting trains of ideas, to suffer itself to be carried by them to an imaginary contemplation of distant scenes, or speaking over of former conversations;—to a recollection of past transactions or anticipation of future enjoyments. This mental observation is known by the name of Reverie: and is also expressed in common conversation by the emphatical metaphor—absence of mind.

Without entering into the question how far

volition is concerned; whether the mind is active or passive in a state of reverie, it will not be improper, for the sake of imparting clearer ideas on the subject, to draw a parallel betwixt reverie and abstraction, according to the common acceptation of the terms.—Abstraction is the act of attending closely to the object of study, which is present to us:—Reverie is the state of being drawn away from an observance of that object, by other reflections. The one indicates strength; the other a degree of weakness of mind:—abstraction is an effort to collect our thoughts: reverie consists in their being let loose, to wander whithersoever they will.—Abstraction is a steady and continued act of pondering on the object before us. Reverie, as it is to be considered in this paper, consists in a want of the power of abstraction.

Abstraction resists the impulses of external objects, which have a tendency to disturb the train of ideas in study. Reverie surrenders the mind to these impulses, and to the new train of ideas, (foreign to the immediate subject of contemplation) which they introduce. Abstraction is peculiar to the philosopher:—reverie to persons of sensibility and genius, uncorrected by strength of mind.—Abstraction

is the habit of the diligent. Reverie, the trifling of the idle.*

Every man is conscious that his mind is often imperceptibly conveyed away from the objects that are presented to his senses, and led to other catenations of ideas. Among these it ranges for some time, till at length, in a manner apparently inexplicable, it perceives itself brought back to its immediate employment; but is equally at a loss to explain how it

* It may, in some cases, at first seem doubtful, whether to refer certain operations of the mind to the former or the latter of these terms. Poetry is one example—But a little reflection will solve the difficulty. Some of the poets' finest ideas may be derived from reverie:—but to embody them in words, to give them a local habitation and a name, close abstraction is certainly required.

It may, also, be proper to observe, that there are two distinct species of reverie; each of which interrupts study. The one is unconnected with the object of our study, and is occasioned by a strong impression on our mind, which disturbs the power of attending to another subject: as if after witnessing an execution, I should attempt to read a book of philosophy, the horrid spectacle would in this case intrude upon my thoughts, and render attention impossible. The other species arises from the subject, and is frequently produced when the mind is at ease. Cato's Soliloquy on reading Plato's Treatise on the Soul's Immortality, may be supposed to be an example of it:—and this species of reverie may easily be confounded with abstraction.

broke loose, how long it has been absent, or what has occasioned its return.

Physicians, who have treated this mental infirmity as a disease, have confined themselves to a description of the constitutional frame, which renders us liable to it.* Having omitted

* Dr. Darwen, vol. 1. p. 361. says that "people with encreased sensibility, who may be known by high coloured lips, dark hair, and large eyes, are most liable to enthusiasm, delirium and reverie. In this last affection, they are seen to start at the clapping of a door, because the more intent any one is on the passing current of his ideas, the more is he surprized at their being dissevered by external violence. But owing to the great expenditure of sensorial power on these sensitive motions, it follows, that there will be a deficiency of it in the irritative, which will be performed with less energy.

Hence these persons do not attend to slight stimulus; but when a stimulus is great enough to excite sensation, it excites greater sensitive actions than in other constitutions. This is the case in delirium or inflammation.—Thus persons addicted to reverie are absent in company;—sit or lie long in one posture, and in winter have the skin of their legs burnt in various colours by the fire. They are fearful of pain; covet music and sleep;—and delight in poetry and romance." As the motions excited in consequence of encreased sensation, are more than natural, and thus expend a greater portion of sensorial power, the voluntary motions, like the irritative, are less easily exerted.—Hence the persons we have been describing are indolent with regard to all voluntary exertions, whether of mind or body. They are also known

to analize the method, by which mind and body act and re-act on each other, they have failed to trace the disease to its source; and in point of remedy, have left it where they found it.

In the course of reading or reflection, the subject which engages us may be a task, or a pleasure; it may either be indifferent to us, or deeply interesting. If it be of the latter description, (or even in the case of the former, if we happen to possess a strength of mind) attention will be collected from every quarter, where it may usually be dissipated, and gathered to this single focus. It seems to leave the organs of sense;—which, hence, become callous to impressions, at other times forcibly perceptible. A bell may toll, and the hail may rattle on their windows; but both may be alike unheard. To this state of the mind, philosophy gives the name of abstraction.—If, on the contrary, I have a more favourite study, than that in which I am engaged; or if, when I am engaged in study, there be some pleasure which I expect or have lately enjoyed; or some misfortune which I apprehend, or have lately sus-

and interrupting others in discourse with irrelevant observations. Deaf people adhere longer than others to one subject, as their train of ideas are in no danger from one inlet of disturbance.

tained, dwelling upon my mind; I shall find it difficult to fix my attention—my thoughts will be perpetually recurring to this more interesting subject; my inclination to wander, and my desire to improve will carry on an equal contest; and I shall discover, on laying aside my book, that I have been reading one thing, and pondering on another. This double operation of the mind, constitutes that species of reverie which is peculiar to literary persons.

Our train of thought is disturbed, when any of our senses is acted upon by some quality in an external object, which tends to introduce a new series of reflections. Thus, distant music may draw away attention from the book we peruse, to a scene, where the same sounds were formerly heard by us. Or, in the course of reading, we may meet with a passage, which suggests reflections irrelevant to the main subject. From these, when the mind is conveyed to them, the transition is easy to others, with which they are connected; and in this manner fancy may rove, for an unlimited time, through an unlimited range of ideas. The ocean, for example, may be introduced as a simile, illustrative of a metaphysical argument. Fancy will be drawn for a moment to the ocean, and if we have ever beheld it, or crossed it, the incident will present itself.—

We then insensibly relinquish our employment, to think on the storm which endangered our life; or on the country and friends, from whence the vessel conveyed us. May not a similar process rouse us from this trance, and recall us to the occupation we had left?—May not a new and unusual impulse upon any organ of sense, startle and remind us, that we are trifling with time?—May not the train of ideas, furnished by the reverie itself, lead us back to the very subject which engaged us, prior to its commencement?—In either way the reverie will be terminated. The firing of cannon may break in upon my fit of absence. When once awakened, but not till then I become conscious that I have been guilty of relaxation from the vigilance of attention, and return to my study, pleased, perhaps, with the excursion, but not without dissatisfaction on account of my loss of time. The same effect may be produced in the instance of the simile already mentioned, if the associated ideas to which the simile of the ocean had led me, taking a retrograde direction, conduct me back to the primary subject of comparison.

When listening to the discourse of an orator, or lecture of a teacher, we digress in a similar manner, and are recalled by a look from the speaker;—by a pause;—by a sudden transition;

a new figure; or a felicity of diction or of thought. This reflection may serve to analize the art of keeping attention awake in others.—It may recommend the impressions we have enumerated, as useful expedients in oratory; and explain the principle, which makes us wish to have a public speaker in our view, while we are listening to him.

When the habit of mental absence is sufficiently confirmed to constitute a disease, the appulses of external objects, which would interrupt reverie in stronger minds, are found to strike upon the senses in vain. A man is mentioned in Zoonomia, who, during the paroxism of reverie, was reciting some lines from Pope, one of which he had forgotten, it was several times ineffectually shouted in his ears; till at length, after much labour, he recollected it by his own efforts. Yet though such appulses do not destroy, they sometimes harmonize with the waking dream. In this case they excite attention; and the reverie, without being broken, insensibly glides into subjects connected with these appulses. In the work we have just now quoted, is an interesting account of a young person, who, while lost in reverie, heard a passing bell; and without being recalled to a consciousness of wandering thought, was soon after heard to

say, "I wish I were in my grave;"—and pulling off her shoe—"A little longer and a little wider; and even this would make a coffin."

Such are the various kinds and degrees of reverie. The enumeration of them was necessary to the discovery of those means by which this mental affection may be regulated or remedied. The subject is of the highest importance to those who are entering upon their studies; since, as it is an argument against wasting much of our time in sleep, that we may be said only to live while we are awake;—so, with regard to letters or business, it may be asserted, that we do not study all the hours we number at our desk, but those only, during which the vigour of our minds has been exerted in our proper employment.

There are several methods by which reverie may be regulated and modified.

1st. The abstraction of excitement produced by external stimuli, will, in most cases, give a preponderance on the side of study, and thus be inimical to reverie. A walk along the shore is more favourable to abstraction, than in a garden or terrace, where the frequent turnings interrupt reflection. Philosophers in general have shunned the town, that its noise and bustle might not disturb their meditations. Nevertheless, we have heard of some, whose

minds were more active amidst the uniform, mingled hum of the throng, or the noise of a carriage, than in more tranquil scenes. This may be accounted for by asserting, 1st. That such uniform sounds may be from habit, associated with abstraction, as opposed to reverie; and that it is only by sharp, sudden impulses, and not by uniform and accustomed sounds, that abstraction is discomposed; and 2dly, That, when this is the case, the sounds in question will drown all others, and thus weaken the influence of their excitement in disturbing abstraction, and producing reverie. Here, however, a difficulty arises. If I remove myself to silence and solitude for the purpose of philosophical abstraction, should reverie by any means find its way to my mind, and experience proves that no silence and no solitude can exclude it,—will not the absence of excitement from external objects be favourable to the continuance of those idle musings, which I have taken pains to avoid?—The first object of a student is, to preclude the advances of reverie; but when its spell has stolen upon him, external stimuli become desirable in order to dissolve it. Hence a retreat into the shade will only facilitate reverie; unless we carry along with us a fund of information, on which we may ruminate; an object of science

to occupy and interest us; and an inherent vigour of mind, which shall enable us to resist the slighter impressions on our senses, from which the deepest retreat is not exempt. The superstitious dreams which are known by the name of second sight, are found amongst the most uninformed of mankind, in a country where the absence of disturbance might favor the highest speculations in science. The beech of the sea, which Plato chose as the fittest place for philosophical instruction, has in our own country become the favourite haunt of the indolent and the unthinking.

Objects and circumstances may be so disposed as to give to reverie a pleasing or pensive, and as we shall presently see, a refined or inelegant direction. I believe it is unnecessary to ask, whether the mind will not be more apt to depart from serious meditation in a gaudy chapel, than in the solemn gloom of a cathedral. It is remarked by an eminent medical writer, that light, introduced by opening the window-shutters, gave a gayer cast to the ideas of a patient who laboured under reverie. The study of Tasso was a Gothic apartment; and he fancied his familiar spirit to converse with him through a window of stained glass.

If we can contrive to effect, during the reverie, a frequent re-action of any circum-

stance connected with our original employment, we shall, by this means, frequently bring back the mind from its excursion. It has been asserted, in favour of the liturgy of the Church of England, that, by being broken into short prayers, and interspersed with frequent responses to be spoken by the people, it is accommodated to the frailty of human nature, and has proved an excellent method of recalling the mind, too apt to wander, even from its most important occupations, and its most sacred duties.

A house of worship is certainly the most suitable place for acts of devotion. The mind is no sooner inattentive, than it sees around it objects connected with religion, which upbraid its weakness and check its aberration.

I now come in the last place to enumerate the remedies I would propose for the diseased state of the mind, which has been the subject of the present dissertation—and these all rest upon a single principle. The "vis insita" of the mind, inclining, by a voluntary exertion to the side of study, constitutes the power of resisting the seducements of external stimuli, and of bidding defiance to reverie:—and as reverie has been shewn to proceed from mental relaxation and debility, so, whatever produces

mental vigour may be pronounced an antidote to it.

Now mental vigour is, in great measure, regulated by the strength of the body; so that literary persons, who are desirous to preserve their minds in a proper disposition for studying with the greatest benefit, should remember, that with respect to exemption from reverie, it is only "in corpore sano" that the "Mens sana" is to be found.

The first remedy accordingly which I shall mention is, frequent and habitual exposure to a pure and bracing atmosphere. The influence of different states of the atmosphere, in sharpening or hebetating the powers of the mind, was so well known to the ancients, that to this cause they sometimes ascribed the diversities of national character. "Inter locorum naturas quantum intersit, vidimus. Athenis, tenue cœlum; ex quo acutiores etiam putantur Attici:——crassum Thebis, itaque pingues Thebani." A sharp and salubrious atmosphere, by invigorating the frame, will thus render the mind alert and active, and intent upon its employment.

Another important remedy for habitual reverie is temperate living, equally removed

from abstinence and excess.* For too great abstinence is a direct cause of mental weakness; while repletion renders body and mind sluggish and torpid.

It is the property of stimulating articles of diet to bestow a temporary vigour, a strong action of the system, which is soon followed by exhaustion. Men of genius, as Brown and Erskine, have accordingly been reported to have swallowed quantities of laudanum, previous to any occasion when it was necessary to call forth all the powers of their mind. Not content with the moderate and judicious tonic of a frugal and healthful meal, they have improvidently applied violent stimulants. But let not this fact be thought to militate against our argument. As long as the stimulus acts, the mind is, doubtless, invigorated. It is enabled to resist the attack of impressions foreign to the subject in which it is engaged;—impressions, which perpetually attempt to lure it from that subject into the mazes of reverie.—But, as the force of the mind is then encreased,

* It is after dinner that our poet Cowper, describes himself as pleased with the movement of his shadow on the cieling, and as thrown into a train of musing by the objects which his fancy beheld in the fire.

by borrowing to-morrow's energy for the service of to-day, to-morrow will be spent in languor. The consequences indeed are less pernicious to the orator than they were to the physician. His mind may recruit its strength before a new exertion of its faculties is demanded. But the lecturer, whose labours were quotidian, must have entered his class with faculties enfeebled and incapable of exertion. Finding his spirits sunk as much below the point of exhilaration, as his last doze had raised them above it, he encreased the quantity of stimulus in a progressive duplicate ratio:— The unfortunate Brown at length fell a victim to dram-drinking.

The Turks, who chew opium in large quantities, are much addicted to reverie. Some traveller relates, that he has observed a native of Turkey sitting from morning till evening in the same posture, poring in a stream where he had fixed a bottle, for the sake of being thrown into a pleasing rumination by the bubbling noise it made with the water.

They who have indulged their minds in a habit of inattention and wandering, are apt to prolong their time of study, that they may finish, before they rise from their desk, the task they have allotted for the day: under the impression that they are by this means redeem-

ing the time they have lost in dissipation of thought.

This is a mistaken economy, and proves no saving of time in the end. He, who, greedy of knowledge, neglects to accustom himself to regular bodily exercise, will find many of the hours which he has passed at his desk, to be undeserving of being computed with the hours of actual improvement: and will thus become sensible, that if a certain portion of time had been given to exercise, the hours of his actual improvement would have been more in number. When the body has been sedentary and indolent, the faculties make fruitless attempts to grasp the objects of their study.—This is the case in reading: it is still more so in composition. With great wisdom, therefore, did the Greeks mingle gymnastic exercises with the study of philosophy. In the morning, after the spirits have been recruited by rest, the mind being (with the body) fresh and vigorous, is not disposed to deviate from the subject presented to it. It was accordingly at this time of the day, that the kings of Egypt transacted all their public business.

In the evening these circumstances are altered. The fatigue and the meals of the day, and the recurrence of the images that have passed before the senses, are inimical to

the vigorous stretch of intense thought. Brutus used to read in his tent, at midnight when his frame was debilitated, and his spirits were exhausted by a long march, and by the heat of the morning;—when his mind was unstrung, and prevented by weariness from exerting its powers in one fixed direction. May not the spectre have been a creature of his imagination when thus pre-disposed for reverie? when his ideas consisted of confused conceptions, furnished partly by his book and partly by his fancy. And will it be deemed extravagant to conjecture, that the passage he was reading may have been the story of the dying Bramin, who prophetically warned Alexander that they should meet at Babylon?

I am aware, that the mind, when deeply engaged in study, sometimes overcomes sleep, and assumes new vigour at a late hour of the night. In this case, a certain degree of fever, in other words, of encreased action, has taken place; which will be followed, and proved to have existed, by commensurate mental debility and nervousness.

"Some," says a modern author, "look over what they want to remember, immediately before going to sleep at night, because then the mind is not afterwards busied about any ideas that might drive it away: or

in the morning on first getting up, because the mind is not then pre-occupied with any ideas which may hinder the subject's getting fast hold of it."——*Gerard's Pastoral Care.*

*On the whole, whatever destroys the balance between body and mind, whatever impairs the firm tone of the animal fibre, ought to be studiously avoided by those whose habits are literary. The debility subsequent to a debauch, a warm climate, fatigue, corpulency, are all favourable to reverie. And every thing that braces the fibre, and gives the system (not

* It is a law in the animal œconomy, that sensibility accumulates as irritability is exhausted: in other words, that the nervous fibre becomes more sensible to impressions, as the muscular fibre becomes less so, and vice versa.—Preternatural or diseased sensibility is not found in the strong labourer so much as in the hysterical and debilitated female. The author of this essay, who can encounter without mental pain, any scenes of distress which he may witness in his professional character, in the morning, when the frame is in tone, has observed in himself a propensity to be much affected by them, when presented to him after fatigue and long fasting. Whatever accumulates sensibility, encreases the mind's liability to be acted upon by external stimuli, and carried away by them from its steady observance of the object of its study. And since the exhaustion of irritability produces this effect, the propriety of the foregoing injunctions is evident.

a sudden and artificial increase of action,) but permanent strength and exhilaration should, with equal care, be resorted to.

But for the mental disorder, which has been the subject of our discussion, we must look, in the second place, for other remedies in the mind itself, when considered abstractedly from the body.

Much benefit will be derived from conquering a sickly taste for light and desultory reading, and abstaining from an immediate application to the fine arts. When they, who have indulged in such pursuits, engage in studies of more solid utility, they find the perusal of historic facts, or the prosecution of philosophical arguments, perpetually interrupted by the involuntary remembrance of their favourite and less severe employments. Mathematics is a science worthy of being recommended to youth, and, indeed, demanding the attention of all whose habits are literary; not so much for its own sake, or for that of the other sciences which cannot be understood without a knowledge of it, as on account of its implanting habits of abstraction and of bestowing the ability to fasten the powers of the mind upon

any subject, and to pursue it till it is thoroughly investigated.*

Here, however, a caution is necessary. Elegant literature and the fine arts, although thus paralysing to the mind when they are made the main object of pursuit, may in certain cases be called in with advantage, as remedies for reverie. When the mind is under the influence of any passion, joy, surprize, grief, indignation, which deprives it of the ease and exemption from solicitude requisite to its applying with effect to abstruse researches or what is called serious reading,—it will then be its philosophy to lure attention into the paths of literature, with the elegant classic, or interesting narrative;—with the works of poets or dramatic authors; and with composition on its favourite theme:—stimulants powerful in calming the soul, and charming sorrow into tranquillity, when rarely and prudently ap-

* In comparing the effects of the different leading branches of education at our two universities, it has been remarked, that persons who have studied at Cambridge, adhere long and steadily to an argument, in conversation; while Oxonians, whose pursuits are more elegant than philosophical, are content with a more superficial examination of many subjects; but afford greater pleasures to their companions, by the desultory variety of the ideas which they communicate.

plied; but which would lose their effect, if they were daily administered.

Another expedient, which it will be prudent to adopt, is the removal of our place of study, beyond the reach (if possible) of every object and circumstance which being presented to any of our senses, is apt to seduce attention. The fragrance of flowers, the voice of music, the portrait of a friend, the hum of men, has each its train of associated ideas, to pursue which, the mind of the student may insensibly be drawn off from the object of his study. And if the student wishes to obtain a depth of thought, a closeness of reasoning, dispatch, or perfection in study, he will reserve these luxuries for the hour of relaxation. It was one of the maxims of Lycurgus, that ornaments should not be placed in the council halls, as they tended to alienate the attention of the judges, when listening to the pleaders.

The art of memory has been said to be the art of attention;—the art of preventing the operations of the mind from being broken by short reveries, to which weak minds are decoyed by every sound or sight that passes. It is possible for a Newton to be so deeply absorbed in thought, and to have practised abstraction so thoroughly, that the firing of a cannon will not break the train of his ideas.

But common minds, conscious of their inferior strength, and of their greater aptitude to be interrupted, should cultivate letters in places where the fewest and the weakest stimuli are applied;—in the shade, remote from noise, and not exposed to passing objects. Colbert's having said that his mind was always most active in the midst of Paris, if not fully solved in the former part of this essay, may be considered as a proof, that that minister possessed a warm imagination, guarded by a vigorous intellect;—that he was willing to give loose to the wanderings of fancy, in the midst of rural leisure: but ever associated the recollection of want of time, and fulness of occupation in the metropolis, with the first aberration of thought from the subject he had before him:—Besides, it is reasonable to suppose, that the studies of Colbert, when in Paris, were confined to the politics of the day; a subject which, by engaging every passion, must have entirely engrossed attention, and deadened the force of external stimuli: whereas his rural lucubrations had, probably, for their subject, topics of speculative philosophy, less interesting, less relating to self and immediate concern; and therefore less endowed with the power of detaining the mind, prone to her favourite sallies of digression from her main employment.

Nothing can be more absurd than an attempt to unite a life of literature and of gaiety.—The remembrance of glaring objects and tumultuous pleasures, perpetually obtruding itself on the mind, will soon convince the scholar, that his efforts to make thought and dissipation of thought meet in the same mind are vain.—The recollection of past, or anticipation of approaching frivolities, makes abstraction a painful and violent, I may safely affirm, an impossible exertion. The conceptions of an effeminate imagination unsettle the mind;—they float upon and confuse the ideas supplied by study.

Indeed a habit of study and abstraction is the most powerful precaution that can be adopted against the intrusions of reverie.—Reverie resembles the enemy of mankind. Resist it, and it will flee from you. The oftener and the more vigorously you oppose it, the less frequently will it recur, and the weaker will be its attacks. While the idler and the man of pleasure cannot peruse even a few pages of a novel without mental weariness and wandering;—the student will in time bring his mind to the ability of prosecuting for many hours, the deepest reasoning, seldom interrupted by reverie, and never overcome.

When speaking of the force of habit, we

cannot fail to recommend the habit of extemporaneous speaking. When a man finds that his words must flow in an uninterrupted succession, and that his ideas MUST keep pace with them, he will have no leisure for idle musing.

Let us suppose, a contention held between the employment which engages us on the one hand, and the stimuli that act upon our senses on the other. Each strives to draw the attention of the mind towards itself. If the employment be pleasing, or if several of the senses, instead of one, be engaged in it, we may consider it as the stronger party, as having the greatest force on its side. Attention would be less apt to waver if we were to transcribe, than if we read a passage in any author; if we saw a drama performed on the stage, than if we perused it in the closet; or if we were present at a parliamentary debate, than if it only reach us through the cold medium of a newspaper. When the mind therefore is agitated, and incapable of intense application, it will be well to betake ourselves to any occupation of which we are enthusiastically fond. Whence arises the fluency of the unlearned itinerant preacher. It is to be ascribed to the two last principles on which we have expatiated, habit and enthusiasm.

It often happens to those who devote much time to reading or composition, that as soon as their reverie commences, they unconsciously remove their eyes from their book or writing desk to some particular spot in the apartment which may be favourable to mental wandering, or associated with it by habit. Now, if they would previously affix to the idea of this spot, the idea of consciousness that they have departed from their proper occupation, they would probably be enabled in this manner to check the fit of musing at its commencement, and to save the time which would otherwise have been squandered. No one is unacquainted with the story of the orator, who could not plead without holding a string in his hand, for the purpose of recalling his wavering thoughts. The biting of our nails, during composition, may be referred to the same cause. We associate the idea of this practice with that of our first and main employment, so that the former is never present without the latter;—and any new train of ideas obtruding themselves on our study are kept at a distance by the recurrence of the practice alluded to; which we have previously identified with the recollection of our original object of contemplation. As nail-biting is intended to fix abstraction, drumming with our fingers is a practice, by

which we promote reverie. This it does, partly from habit and partly upon a principle already mentioned; namely, that a gentle uniform stimulus draws attention from all others, except such as are sudden and violent; which will dissolve any reverie, however interesting, and however artfully promoted, unless in a diseased state of the mind.

If, therefore, we find that this last mentioned practice is favourable to the continuance of our minds in the regions of imagination, we must frequently, when we have greater command over our thoughts, study to connect and blend the practice with internal disapprobation of our indolence.

If, however, the habit of reverie have been too deeply fixed in our minds to be entirely eradicated;—or if (as is the case with many) we be unwilling to part with this pleasing weakness, and consider the moment spent in such desultory musings, as the most delightful of our lives, we ought still to be anxious to regulate them in such a manner as to prevent them from being either unprofitable or criminal.

We may hinder them from becoming unprofitable, by cultivating a taste for intellectual pleasures; by habitual application to a variety of branches of study;—and by frequenting the

society of the learned or the refined. The reverie, which we cannot conquer, will thus be converted into a rational employment;—for taste and memory will direct it to subjects of science and utility.

The best rules for preventing fits of absence from becoming criminal, will be found in that book, which is the highest authority on this part of the subject. Keep the heart with diligence, for out of it proceed evil thoughts;—the springs of conduct; the issues of life. Be strenuous in "casting down imaginations" that are contrary to virtue; and "bringing every thought into the captivity of principle."—The authors of the book from whence these maxims are extracted, were aware, that it was impossible to put an entire end to the influence of matter over the mind, and to abolish reverie. They knew that as long as the human frame continued in its present condition;—"the corruptible body would press down the incorruptible soul."—They therefore enjoined the purification of the thoughts; in order, that whenever matter should exert its influence upon mind, and force it into unconscious deviation from its employment, mind might be invariably led by inclination into the paths of innocent or pious musing:—Quinctilian relates of his son, that in conse-

quence of his strong attachment to letters, no word escaped him in the delirium of a fever, that had not a reference to his favourite occupation. Thus when the scientific mind recovers from a paroxysm of reverie, it has the satisfaction of reflecting that its time has been well employed;—that if it has not been meditating some new effort of its powers, it has, perhaps, been dwelling on some elegant thought, or glowing description treasured up in study, or heard in conversation. And, in like manner, when the reverie of the virtuous man is at an end, he finds, that, while it lasted, he has either been forming a good purpose, or acting over in fancy, a benevolent deed.

Far different trains of thought pass through the imaginations of the ignorant, the vicious, the sensual. If their minds are not mechanically driven to recollections that are full of remorse and bitterness, the highest pleasures of their reveries are the remembrance of some frivolous enjoyment, or anticipation of the pampering of some base appetite. An Apicius will feast again in fancy on the banquet of yesterday. An Alexander's mind will leave the scene which surrounds it; "thrice to vanquish all his foes, and thrice to slay the slain." How far in frivolous minds a human passion

will get the better even of devotion, may be seen by referring to our great dramatic bard.—

" When I would think and pray, I think and pray,
To several subjects heaven hath my empty words,
Whilst my invention, hearing not my tongue, anchors on Isobel."

Idle and unprofitable reveries may be also broken, by having our study hung round with portraits of heroes and worthies; of ancient and modern authors; of any who have attained eminence or power, by mental activity and perseverance, and are calculated to rouse the slumbering mind to emulation and energy. And in like manner may we dissolve the spell of reveries, into which evil thoughts are apt to enter, by the pictures of a Saviour, or of a departed or sainted friend. Who would not return, with a blush, from whatever criminal conceptions he had hung upon, when he encountered the eye, and fancied that he beheld the frown of personages so sacred?

To propose a total preventive or cure for the disease I have been considering, has neither been my aim nor my wish. The aim would be ineffectual, as long as mind and body depend and reciprocally act on each other, as they do in the present existence.—The wish would be the dictate of that cold philosophy, which seeks to shut up one inlet

of those few, harmless delights, that heaven has apportioned to us, and that nature has commanded us to husband. Yet this riot of fancy should be seldom and carefully indulged. If it be sometimes allowable to slacken the reins, with which the mind is held attentive, never let us throw them entirely away;—for though it would be pedantry to suggest, that since moments thus passed, are inconsistent with our active duties, they ought, without reservation, to be condemned;—we ought, nevertheless, to beware of every relaxation, which pre-disposes the mind to habitual inactivity.

Stimuli may be encreased to so intense a degree, that attention will be compelled to leave the fondest object on which it broods, and to obey their impulse. For although we have read, that Archimedes was solving a problem during the sack of Syracuse, that Newton was often insensible to his meals having been brought before him and removed; that Cicero calmly pursued his studies while his mind was dejected by domestic grief and harassed by public vexation;—yet it is certain, that pain or hunger, fear or sorrow, or joy, or any violent passion, will, in most minds, overcome the deepest and most philosophical abstraction.

Little credit is due to the story of an Italian philosopher's being so wholly absorbed in contemplation, as to be unconscious that he was upon the rack.—Let us call to mind an elegant sentiment of our Master of Nature, whose works every philosopher who reads them will often have occasion to quote:—

> Oh! who can hold a fire in his hand
> By thinking of the frosty Caucasus, &c.

Philosophers, nevertheless, there are, who assert, that man may in time become so perfect, that his mind shall be unaffected by variations in the state of his body. But even were this improbability to be desired, it surely cannot be expected;—for their mutual reliance is at present so great, that it justifies the conclusion, that mind will never become omnipotent over matter, until it shall be altogether independent of it.

EXPERIMENTAL ENQUIRY *into the* PROPORTION *of the several* GASES *or* ELASTIC FLUIDS, *constituting the* ATMOSPHERE.

By JOHN DALTON.

Read Nov 12, 1803.

IN a former paper which I submitted to this society, "on the constitution of mixed gases," I adopted such proportions of the simple elastic fluids to constitute the atmosphere as were then current, not intending to warrant the accuracy of them all, as stated in the said paper; my principal object in that essay was, to point out the *manner* in which mixed elastic fluids exist together, and to insist upon what I think a very important and fundamental position in the doctrine of such fluids:—namely, that the elastic or repulsive power of each particle is confined to those of its own kind; and consequently the force of such fluid, retained in a given vessel, or gravitating, is the same in a

separate as in a mixed state, depending upon its proper density and temperature. This principle accords with all experience, and I have no doubt will soon be perceived and acknowledged by chemists and philosophers in general; and its application will elucidate a variety of facts, which are otherwise involved in obscurity.

The objects of the present essay are,

1. To determine the weight of each simple atmosphere, abstractedly; or, in other words, what part of the weight of the whole compound atmosphere is due to azote; what to oxygen, &c. &c.

2. To determine the relative weights of the different gases in a given volume of atmospheric air, such as it is at the earth's surface.

3. To investigate the proportions of the gases to each other, such as they ought to be found at different elevations above the earth's surface.

To those who consider the atmosphere as a chemical compound, these *three* objects are but *one*; others, who adopt my hypothesis, will see they are essentially distinct.—With respect to the first: It is obvious, that, on my hypothesis, the density and elastic force of each gas at the earth's surface, are the effects of

the weight of the atmosphere of that gas solely, the different atmospheres not gravitating one upon another. Whence the first object will be obtained by ascertaining what share of elastic force is due to each gas in a given volume of the compound atmosphere; or, which amounts to the same thing, by finding how much the given volume is diminished under a constant pressure, by the abstraction of each of its ingredients singly. Thus, if it should appear that by extracting the oxygenous gas from any mass of atmospheric air, the whole was diminished $\frac{1}{5}$ in bulk, still being subject to a pressure of 30 inches of mercury; then it ought to be inferred that the oxygenous atmosphere presses the earth with a force of 6 inches of mercury, &c.

In order to ascertain the second point, it will be further necessary to obtain the specific gravity of each gas; that is, the relative weights of a given volume of each in a pure state, subject to the same pressure and temperature. For, the weight of each gas in any given portion of atmospheric air, must be in the compound ratio of its force and specific gravity.

With respect to the third object, it may be observed, that those gases which are specifically the heaviest must decrease in density the

quickest in ascending. If the earth's atmosphere had been a homogeneous elastic fluid of the same weight it is, but ten times the specific gravity, it might easily be demonstrated that no sensible portion of it could have arisen to the summits of the highest mountains. On the other hand, an atmosphere of hydrogenous gas, of the same weight, would support a column of mercury nearly 29 inches on the summit of Mount Blanc.

The several gases constantly found in every portion of atmospheric air, and in such quantities as are capable of being appreciated, are azotic, oxygenous, aqueous vapour, and carbonic acid. It is probable that hydrogenous gas also is constantly present; but in so small proportion as not to be detected by any test we are acquainted with; it must therefore be confounded in the large mass of azotic gas.

I. *Of the weight of the Oxygenous and Azotic Atmospheres.*

Various processes have been used to determine the quantity of oxygenous gas.

1. The mixture of nitrous gas and air over water.

2. Exposing the air to liquid sulphuret of potash or lime, with or without agitation.

3. Exploding hydrogen gas and air by electricity.

4. Exposing the air to a solution of green sulphat or muriat of iron in water, strongly impregnated with nitrous gas.

5. Burning phosphorus in the air.....

In all these cases the oxygen enters into combination and loses its elasticity; and if the several processes be conducted skilfully, the results are precisely the same from all. In all parts of the earth and at every season of the year, the bulk of any given quantity of atmospheric air appears to be reduced nearly 21 per cent. by abstracting its oxygen. This fact, indeed, has not been generally admitted till lately; some chemists having found, as they apprehended, a great difference in the quantity of oxygen in the air at different times and places; on some occasions 20 per cent. and on others 30, and more of oxygen are said to have been found. This I have no doubt was owing to their not understanding the nature of the operation and of the circumstances influencing it. Indeed it is difficult to see, on any hypothesis, how a disproportion of these two elements should ever subsist in the atmosphere.

As the first of the processes above-mentioned has been much discredited by late authors, and

as it appears from my experience to be not only the most elegant and expeditious of all the methods hitherto used, but also as correct as any of them, when properly conducted, I shall, on this occasion, animadvert upon it.

1. Nitrous gas may be obtained pure by nitric acid diluted with an equal bulk of water poured upon copper or mercury; little or no artificial heat should be applied.—The last product of gas this way obtained, does not contain any sensible portion of azotic gas; at least it may easily be got with less than 2 or 3 per cent. of that gas: It is probably nearly free from nitrous oxide also, when thus obtained.

2. If 100 measures of common air be put to 36 of pure nitrous gas in a tube 3-10th of an inch wide and 5 inches long, after a few minutes the whole will be reduced to 79 or 80 measures, and exhibit no signs of either oxygenous or nitrous gas.

3. If 100 measures of common air be admitted to 72 of nitrous gas in a wide vessel over water, such as to form a thin stratum of air, and an immediate momentary agitation be used, there will, as before, be found 79 or 80 measures of pure azotic gas for a residuum.

4. If, in the last experiment, *less* than 72 measures of nitrous gas be used, there will be a

residuum containing oxygenous gas; if *more*, then some residuary nitrous gas will be found.

These facts clearly point out the theory of the process: the elements of oxygen may combine with a certain portion of nitrous gas, or with twice that portion, but with no intermediate quantity. In the former case *nitric* acid is the result; in the latter *nitrous* acid: but as both these may be formed at the same time, one part of the oxygen going to *one* of nitrous gas, and another to *two*, the quantity of nitrous gas absorbed should be variable; from 36 to 72 per cent. for common air. This is the principal cause of that diversity which has so much appeared in the results of chemists on this subject. In fact, all the gradation in quantity of nitrous gas from 36 to 72 may actually be observed with atmospheric air of the same purity; the wider the tube or vessel the mixture is made in, the quicker the combination is effected, and the more exposed to water, the greater is the quantity of *nitrous* acid and the less of *nitric* that is formed.

To use nitrous gas for the purpose of eudiometry therefore, we must attempt to form *nitric acid* or *nitrous* wholly, and without a mixture of the other. Of these the former appears from my experiments to be most easily and most accurately effected. In order to this a narrow

tube is necessary; one that is just wide enough to let air pass water without requiring the tube to be agitated, is best.—Let little more nitrous gas than is sufficient to form nitric acid be admitted to the oxygenous gas; let no agitation be used; and as soon as the diminution appears to be over for a moment let the residuary gas be transferred to another tube, and it will remain without any further diminution of consequence. Then $\frac{7}{79}$ of the loss will be due to oxygen.—The transferring is necessary to prevent the nitric acid formed and combined with the water, from absorbing the remainder of the nitrous gas to form nitrous acid.

Sulphuret of lime is a good test of the proportion of oxygen in a given mixture, provided the liquid be not more than 20 or 30 per cent. for the gas (atmospheric air); if the liquid exceed this, there is a portion of azotic gas imbibed somewhat uncertain in quantity.

Volta's eudiometer is very accurate as well as elegant and expeditious: according to Monge, 100 oxygen require 196 measures of hydrogen; according to Davy 192; but from the most attentive observations of my own, 185 are sufficient. In atmospheric air I always find 60 per cent. diminution when fired with an excess of hydrogen; that is, 100 common

air with 60 hydrogen, become 100 after the explosion, and no oxygen is found in the residuum; here 21 oxygen take 39 hydrogen.

2. *Of the weight of the Aqueous Vapour in the Atmosphere.*

I have, in a former essay, (Manchester Mem. vol. 5. p. 2, page 559.) given a table of the force of vapour in *vacuo* for every degree of temperature, determined by experiment; and in the sequel of the essay, have shewn that the force of vapour in the atmosphere is the very same as in *vacuo*, when they are both at their utmost for any given temperature. To find the force of aqueous vapour in the atmosphere, therefore, we have nothing more to do than to find that degree of cold at which it begins to be condensed, and opposite to it in the table abovementioned, will be found the force of vapour. From the various facts mentioned in the essay it is obvious, that vapour contracts no chemical union with any of the gases in the atmosphere; this fact has since been enforced in the Annales de Chimie, vol. xlii. by Clement and Desormes.

M. De Saussure found by an excellent experiment, that dry air of 64° will admit so much vapour as to increase its elasticity, $\frac{1}{24}$.—

This I have repeated nearly in his manner, and found a similar result. But the table he has given us of aqueous vapour at other temperatures is very far wrong, especially at temperatures distant from 64°.—The numbers were not the result of direct experiment, like the one above.—If we could obtain the temperatures of all parts of the earth's surface, for any given time, a mean of them would probably be 57° or 58°. Now if we may suppose the force of vapour equivalent to that of 55°, at a medium, it will, from the table, be = to .443 of mercury; or, nearly $\frac{1}{70}$ of the whole atmosphere. This it will be perceived is calculated to be the weight of vapour in the whole atmosphere of the earth. If that incumbent over any place at any time be required, it may be found as directed above.

3. *Of the weight of the Carbonic Acid Atmosphere.*

From some observations of Humboldt, I was led to expect about $\frac{1}{100}$ part of the weight of the atmosphere to be carbonic acid gas: but I soon found that the proportion was immensely over-rated. From repeated experiments, all nearly agreeing in their results, and made at

different seasons of the year, I have found, that if a glass vessel filled with 102,400 grains of rain water be emptied in the open air, and 125 grains of strong lime water be poured in, and the mouth then closed; by sufficient time and agitation, the whole of the lime water is just saturated by the acid gas it finds in that volume of air. But 125 grains of the lime water used require 70 grain measures of carbonic acid gas to saturate it; therefore, the 102,400 grain measures of common air contain 70 of carbonic acid; or $\frac{1}{1460}$ of the whole.—The weight of the carbonic acid atmosphere then is to that of the whole compound as 1 : 1460; but the weight of carbonic acid gas in a given portion of air at the earth's surface, is nearly $\frac{1}{1000}$ of the whole; because the specific gravity of the gas is $1\frac{1}{2}$ that of common air. I have since found that the air in an assembly, in which two hundred people had breathed for two hours, with the windows and doors shut, contained little more than 1 per cent. of carbonic acid gas.

Having now determined the force with which each atmosphere presses on the earth's surface, or in other words, its weight; it remains next to enquire into their specific gravities.

These may be seen in the following Table.

Atmospheric air, ...	1.000
Azotic gas, ...	.966
Oxygenous gas, ...	1.127
Carbonic acid gas, ...	1.500
Aqueous vapour, ...	.700
Hydrogenous gas.	.077*

Kirwan and Lavoisier are my authorities for these numbers; except oxygenous gas and aqueous vapour. For the former I am indebted to Mr. Davy's Chemical Researches; his number is something greater than theirs: I prefer it, because, being determined with at least equal attention to accuracy with the others, it has this further claim for credit, that 21 parts of gas of this specific gravity, mixed with 79 parts of azotic gas, make a compound of exactly the same specific gravity as the atmosphere, as they evidently ought to do, setting aside the unfounded notion of their forming a *chemical* compound. The specific gravity of aqueous vapour I have determined

* The specific gravity of hydrogen must be rated too low: if 100 oxygen require 185 hydrogen by measure, according to this 89 oxygen would require only 11 hydrogen to form water; whereas 85 require 15. Hydrogen ought to be found about $\frac{1}{10}$ part of the weight of common air.

myself both by analytic and synthetic methods, after the manner of De Saussure; that is, by abstracting aqueous vapour of a known force from a given quantity of air, and weighing the water obtained—and admitting a given weight of water to dry air and comparing the loss with the increased elasticity. De Saussure makes the specific gravity to be ,71 or ,75; but he used caustic alkali as the absorbent, which would extract the carbonic acid as well as the aqueous vapour from the air. From the experiments of Pictet and Watt, I deduce the specific gravity of aqueous vapour to be ,61 and ,67 respectively. Upon the whole, therefore, it is probable that ,7 is very nearly accurate.

We have now sufficient data to form tables answering to the two first objects of our enquiry.

I. *Table of the Weights of the different Gases constituting the Atmosphere.*

	Inch. of Mercury.
Azotic gas	23. 36
Oxygenous gas	6. 18
Aqueous vapour	.44
Carbonic Acid gas	.02
	30 . 00

II. *Table of the proportional weights of the different Gases in a given volume of Atmospheric Air, taken at the Surface of the Earth.*

	per cent.
Azotic gas	75. 55
Oxygenous gas	23. 32
Aqueous vapour	1. 03*
Carbonic acid gas	—. 10
	100. 00

III. *On the Proportion of Gases at different Elevations.*

M. Berthollet seems to think that the lower strata of the atmosphere ought to contain more oxygen than the upper, because of the greater specific gravity of oxygenous gas, and the slight affinity of the two gases for each other. (See Annal. de Chimie, Tom. 34. page 85.) As I am unable to conceive even the possibility of two gases being held together by affinity, unless their particles unite so as to form *one* centre of repulsion out of two or more (in

* The proportion of aqueous vapour must be understood to be variable for any one place: the others are permanent or nearly so.

which case they become *one* gas) I cannot see why rarefaction should either decrease or increase this supposed affinity. I have little doubt, however, as to the fact of oxygenous gas observing a diminishing ratio in ascending; for, the atmospheres being independent on each other, their densities at different heights must be regulated by their specific gravities.—Hence, if we take the azotic atmosphere as a standard, the oxygenous and the carbonic acid will observe a decreasing ratio to it in ascending, and the aqueous vapour an increasing one. The specific gravity of oxygenous and azotic gases being as 7 to 6 nearly, their diminution in density will be the same at heights reciprocally as their specific gravities. Hence it would be found, that at the height of Mount Blanc (nearly three English miles) the ratio of oxygenous gas to azotic in a given volume of air, would be nearly as 20 to 80;—consequently it follows that at any ordinary heights the difference in the proportions will be scarcely if at all perceptible.*

* Air brought from the summit of Helvelyn, in Cumberland (1100 yards above the sea—Barometer being 26,60) in July 1804, gave no perceptible difference from the air taken in Manchester.—M. Gay-Lussac determines the constitution of air brought from an elevation of four miles to be the same as that at the earth's surface.

On the TENDENCY *of* ELASTIC FLUIDS *to* DIFFUSION *through each other.*

By JOHN DALTON.

Read Jan. 28, 1803.

IN an early period of pneumatic chemistry it was discovered that elastic fluids of different specific gravities being once diffused through each other, do not of themselves separate, by long standing, in such manner as that the heaviest is found in the lowest place; but on the contrary, remain in a state of uniform and equal diffusion.

Dr. Priestley has given us a section on this subject (vid. Experiments and Observations. &c. abridged. Vol. 2. page 441) in which he has proved the fact above-mentioned in a satisfactory manner; and every one's experience since, as far as I know, has coincided with his conclusions. He has not offered any conjecture concerning the cause of this deviation from the

law observed by inelastic fluids; but he suggests that " if two kinds of air of very " different specific gravities, were put into the " same vessel, with very great care, without " the least agitation that might mix or blend " them together, they might continue separate, " as with the same care *wine* and *water* may " be made to do."

The determination of this point, which seems at first view but a trivial one, is of considerable importance; as from it we may obtain a striking trait, either of the agreement or disagreement of elastic and inelastic fluids in their mutual action on each other.

It is, therefore, the subject of the following experiments to ascertain whether two elastic fluids brought into contact, could intermix with each other, independently of agitation. The result seems to give it in the affirmative beyond a doubt, contrary to the suggestion of Dr. Priestley; and establishes this remarkable fact, *that a lighter elastic fluid cannot* REST *upon a heavier*, as is the case with liquids; but, they are constantly active in diffusing themselves through each other till an equilibrium is effected, and that without any regard to their specific gravity, except so far as it accelerates or retards the effect, according to circumstances.

The only apparatus found necessary was a few phials, and tubes with perforated corks; the tube mostly used was one 10 inches long, and of $\frac{1}{20}$ inch bore; in some cases a tube of 30 inches in length and $\frac{1}{3}$ inch bore was used; the phials held the gases that were subjects of experiment and the tube formed the connection. In all cases, the heavier gas was in the *under* phial, and the two were placed in a perpendicular position, and suffered to remain so during the experiment in a state of rest; thus circumstanced it is evident that the effect of agitation was sufficiently guarded against; for, a tube almost capillary and ten inches long, could not be instrumental in propagating an intermixture from a momentary commotion at the commencement of each Experiment.

FIRST CLASS.

CARBONIC ACID GAS,

with Atmospheric Air, Hydrogenous, Azotic and Nitrous Gases.

1. A pint phial filled with carbonic acid gas, the 30 inch tube and an ounce phial, the tube and small phial being filled with common air, were used at first. In one hour the small phial was removed, and had acquired no sen-

sible quantity of acid gas, as appeared from agitating lime water in it. In three hours it had the acid gas in great plenty, instantly making lime water milky. After this it was repeatedly removed in the space of half an hour, and never failed to exhibit signs of the acid gas. Things remaining just the same, the upper phial was filled with the different gases mentioned above repeatedly, and in half an hour there was always found acid sufficient to make the phial $\frac{1}{2}$ filled with lime water quite milky. There was not any perceptible difference whatever gas was in the upper phial.*

SECOND CLASS.

HYDROGENOUS GAS,

with Atmospheric Air and Oxygenous Gas.

1. Two 6 ounce phials were connected by the tube of a tobacco pipe, 3 inches long, the upper containing hydrogenous gas, the lower atmospheric air: after standing two hours, the lower phial was examined; the mixed gases it contained made six explosions in a small phial. The gas in the upper also exploded.

* The small tube of 10 inches was then used and a phial of common air; in one hour much acid gas had come through, as appeared by lime water.

2. Two 4 ounce phials connected with the 10 inch small tube stood two days, having common air and hydrogen gas. Upon examination the upper was found to be $\frac{1}{3}$ common air by the test of nitrous gas. The gas in the under exploded smartly; that in the upper moderately with a lambent flame.

3. Two 1 ounce phials were connected by the 10 inch tube, containing common air and hydrogenous gas; in $3\frac{1}{2}$ hours the upper was about $\frac{1}{3}$ common air and the under $\frac{2}{3}$; the former exploded faintly; the latter smartly.

4. Two 1 ounce phials were connected as above; the under containing gas about $\frac{3}{4}$ oxygenous, the upper hydrogenous: In three hours the latter was $\frac{1}{5}$ oxygenous, and the former about $\frac{1}{2}$; the upper exploded violently; the under, moderately.

5. Two 1 ounce phials were again connected, the lower having atmospheric air, the upper hydrogenous gas; they stood fifteen hours, and were then examined; the upper gave 1.67 with nitrous gas, the under 1.66.—Hence it is evident that an equilibrium had taken place, or the two gases were uniformly diffused through each other in both phials.

THIRD CLASS.

NITROUS GAS,

with Oxygenous Gas, Atmospheric Air, Hydrogenous and Azotic Gases.

The results of the preceding experiments upon gases that have no known affinity for each other, were conformable to what *à priori*, I had conceived; for, according to my hypothesis, every gas diffuses itself equably through any given space that may be assigned to it, and no other gas being in its way can *prevent*, though it may considerably *retard* this diffusion. But in some of the following experiments, in which the two gases are known to have a chemical affinity for each other, I expected different results from what were found; perhaps without sufficient reason. For, chemical union cannot take place till the particles are brought into contiguity; and the elastic force which sets them in motion appears, from the above experiments, to be a principle diametrically opposite to affinity.—That circulation of elastic fluids, therefore, which we have now before us, cannot be *accelerated* by their having a chemical affinity for each other. Another circumstance deserves

explanation ;—when nitrous and oxygenous gas are in the two phials, the residuary gases after the experiment are nearly as pure as before; because those portions of them that meet in the tube, form nitrous acid vapour, which is absorbed by the moisture in the phials, and therefore does not contaminate either gas.

1. Two 1 ounce phials were connected with the small tube, the under containing nitrous gas, the upper atmospheric air; after three hours, the upper phial was taken off when a quantity of air was perceived to enter, as was expected; the air in the upper phial was scarcely distinguishable from what it was at first; that in the under phial was still so much nitrous as to require its own bulk of common air to saturate it.

2. The above experiment was repeated, and the upper phial drawn off when the whole was under water, in order to prevent communication with the atmosphere: about $\frac{1}{9}$ of an ounce of water entered the phials, to compensate the diminution. Remaining air in the upper phial was a very little worse than common air, it being of the standard 1,47 when the former was 1,44. The gas in the under phial was still nitrous and nearly of the same

purity as at first; for 3 parts of it required 4 of atmospheric air to saturate them.

3. Nitrous gas and one $\frac{2}{3}$ oxygenous were tried in the same way: after four hours, the apparatus was taken down under water. The upper phial was $\frac{1}{3}$ filled with water, and the gas in it was partly driven down the tube into the other phial, by which, and the previous process, the nitrous gas was completely saturated and nothing but azotic with a small portion of oxygenous were found in the under phial: the remaining gas in the upper phial was still $\frac{1}{2}$ oxygenous.

4. Nitrous gas and hydrogenous: in three hours the upper phial was $\frac{1}{4}$ nitrous, and of course the under must have a like part of hydrogen.

5. Nitrous gas and azotic: after three hours the upper phial was $\frac{1}{5}$ nitrous.

In the two last experiments, the quantity of nitrous gas in the upper phial was less than might be expected; but the tube was at first filled with common air, and some must enter on connecting the apparatus, which is sufficient to account for the results.

FOURTH CLASS.

AZOTIC GAS,

with mixtures containing oxygenous gas.

1. Azotic gas and one $\frac{2}{3}$ oxygenous: after standing three hours the upper phial was of the standard 1.78, or about $\frac{1}{14}$ oxygenous.

2. Azotic gas with atmospheric air: after standing three hours the upper phial was not sensibly diminished by nitrous gas; the under phial, however, had lost 2 per cent. or $\frac{1}{50}$ of its oxygen. The reason of this was, that the azotic gas in this experiment having been just made for it from nitrous gas, this last had not been completely saturated with atmospheric air, and hence had seized upon all the oxygen ascending into the upper phial.

Having now related all the experiments I made of any importance to the subject, it will be proper to add, for the sake of those that may wish to repeat some of them, that great care must be taken to keep the inside of the tube dry; for if a drop of water interpose between the two gases, I have found that it effectually prevents the intercourse: Glass tubes should therefore be used, that one may be satisfied on this head, as the obstruction will then be visible.

I shall make no further comments on the above experiments, by way of explanation; because to those who understand my hypothesis of elastic fluids, they need none: and I think it would be in vain to attempt an explation any other way. I cannot however, on this occasion, avoid adverting to some experiments of Dr. Priestley, which few modern philosophers can be unacquainted with: I mean those relating to the seeming conversion of water into air. (Vid. Philos. Transact. vol. 73, page 414—or his Expts. abridged, vol. 2, page 407.) He found that unglazed earthen retorts containing a little moisture, when heated, admitted the external air to pass through their pores at the same time that aqueous vapour passed through the pores the contrary way or outward; and that this last circumstance was *necessary* to the air's entrance. The retorts are air-tight, so far as that blowing into them discovers no pores; but when subjected to a greater pressure, as that of the atmosphere, or even one much short of it, they are not able to prevent the passage of elastic fluids. The fact of air passing into the retort through its pores, and vapour out of them at the same time, are elegantly and most convincingly shewn by Dr. Priestley's experiments, in which he used the apparatus represented in plate 7, fig. 1, of the edition above referred to.

The Doctor confesses his explanation of these remarkable facts is very inadequate; and no wonder, for it is impossible for him or any other to explain them on the commonly received principles of elastic fluids. But we will hear what he says on the subject:—"At present it "is my opinion, that the agent in this case is "that principle which we call *attraction* of "*cohesion*, or that power by which water is "raised in capillary tubes. But in what "manner it acts in this case I am far from "being able to explain. Much less can I "imagine how *air* should pass one way and "*vapour* the other, in the same pores, and "how the transmission of the one should be "necessary to the transmission of the other.— "I am satisfied, however, that it is by means "of such pores as air may be forced through, "that this curious process is performed; be- "cause the experiment never succeeds but "in such vessels as, by the air pump at least, "appear to be porous, though in all such."

The truth is, these facts so difficult to explain are exactly similar to those which are the subject of this Memoir: Only instead of a *great number* of pores we have *one* of sensible magnitude, (the bore of the tube). Let the porous retort have the same elastic fluid within and without, in the one case; and the two

phials contain the same elastic fluid in the other, then no transmission is observable in either: but if the retort have common air, or any other gas, without, and aqueous vapour, or any other elastic fluid, except the outside one, within; then the motion in and out commences, just as with the phials in similar circumstances. In fact this last observation has since been verified by Dr. Priestley himself, of which an account is given in No. 2, of the American Philosophical Transactions, vol. 5. After alluding to his experiments above-mentioned he observes, "Since that time I have "extended and diversified the experiments, "and have observed, that what was done by "*air* and *water*, will be done by *any two* "*kinds of air*, and whether they have affinity "to one another or not, that this takes place "in circumstances of which I was not at all "apprized before, and such as experimenters "ought to be acquainted with, in order to "prevent mistakes of considerable conse-"quence."

The facts stated above, taken altogether, appear to me to form as decisive evidence *for* that theory of elastic fluids which I maintain, and *against* the one commonly received, as any physical principle which has ever been deemed a subject of dispute, can adduce.

ON THE

ABSORPTION OF GASES

BY

Water and other Liquids.

By JOHN DALTON.

Read October 21, 1803.

1. IF a quantity of pure water be boiled rapidly for a short time in a vessel with a narrow aperture, or if it be subjected to the air-pump, the air exhausted from the receiver containing the water, and then be briskly agitated for some time, very nearly the whole of any gas the water may contain, will be extricated from it.

2. If a quantity of water thus freed from air be agitated in any kind of gas, not chemically uniting with water, it will absorb its bulk of the gas, or otherwise a part of it equal to some one of the following fractions, namely, $\frac{1}{8}$, $\frac{1}{27}$, $\frac{1}{64}$, $\frac{1}{125}$, &c. these being the cubes of the reciprocals of the natural numbers 1, 2, 3, &c. or $\frac{1}{1^3}$, $\frac{1}{2^3}$, $\frac{1}{3^3}$, $\frac{1}{4^3}$, &c. the same gas always being absorbed in the same proportion,

as exhibited in the following table:—It must be understood that the quantity of gas is to be measured *at the pressure and temperature with which the impregnation is effected.*

Bulk absorbed, the bulk of water being unity.	
$\frac{1}{1^3} = 1$	Carbonic acid gas, sulphuretted hydrogen, nitrous oxide.*
$\frac{1}{2^3} = \frac{1}{8}$	Olefiant gas, of the Dutch chemists.
$\frac{1}{3^3} = \frac{1}{27}$	Oxygenous gas, nitrous gas,† carburetted hydrogen gas, from stagnant water.
$\frac{1}{4^3} = \frac{1}{64}$	Azotic gas, hydrogenous gas, carbonic oxide.
$\frac{1}{5^3} = \frac{1}{125}$	None discovered.

3. The gas thus absorbed may be recovered from the water the same in quantity and qua-

* According to Mr. William Henry's experiments, water does not imbibe quite its bulk of nitrous oxide; in one or two instances with me it has come very near it: The apparent deviation of this gas, may be owing to the difficulty of ascertaining the exact degree of its impurity.

† About $\frac{1}{20}$ of nitrous gas is usually absorbed; and $\frac{1}{27}$ is recoverable: This difference is owing to the residuum of oxygen in the water, each measure of which takes $3\frac{1}{2}$ of nitrous gas to saturate it, when in water. Perhaps it may be found that nitrous gas usually contains a small portion of nitrous oxide.

lity as it entered, by the means pointed out in the 1st article.

4. If a quantity of water free from air be agitated with a mixture of two or more gases (such as atmospheric air) the water will absorb portions of each gas the same as if they were presented to it separately in their proper density.

Ex. gr. Atmospheric air, consisting of 79 parts azotic gas, and 21 parts oxygenous gas, per cent.

Water absorbs $\frac{1}{64}$ of $\frac{79}{100}$, azotic gas = 1.234

——————— $\frac{1}{27}$ of $\frac{21}{100}$, oxygen gas = .778

Sum, per cent. 2.012

5. If water impregnated with any one gas (as hydrogenous) be agitated with another gas *equally* absorbable (as azotic) there will *apparently* be no absorption of the latter gas; just as much gas being found after agitation as was introduced to the water; but upon examination the residuary gas will be found a *mixture* of the two, and the parts of each, in the water, will be exactly proportional to those out of the water.

6. If water impregnated with any one gas be agitated with another gas less or more absorbable; there will *apparently* be an increase

or diminution of the latter; but upon examination the residuary gas will be found a *mixture* of the two, and the proportions agreeable to article 4.

7. If a quantity of water in a phial having a ground stopper very accurately adapted, be agitated with any gas, or mixture of gases, till the due share has entered the water; then, if the stopper be secured, the phial may be exposed to any variation of *temperature*, without disturbing the equilibrium: That is, the quantity of gas in the water will remain the same whether it be exposed to heat or cold, if the stopper be air-tight.

N. B. The phial ought not to be near full of water, and the temperature should be between 32° and 212°.

8. If water be impregnated with one gas (as oxygenous), and another gas, having an affinity for the former (as nitrous), be agitated along with it; the absorption of the latter gas will be greater, by the quantity necessary to saturate the former, than it would have been if the water had been free from gas.*

* One part of oxygenous gas requires 3.4 of nitrous gas to saturate it in water. It is agreeable to this that the rapid mixture of oxygenous and nitrous gas over a broad surface of water, occasions a greater diminution than otherwise. In fact, the *nitrous* acid is formed this way; whereas when

9. Most liquids free from viscidity, such as acids, alcohol, liquid sulphurets, and saline solutions in water, absorb the same quantity of gases as pure water; except they have an affinity for the gas, such as the sulphurets for oxygen, &c.

The preceding articles contain the principal facts necessary to establish the theory of absorption: Those that follow are of a subordinate nature, and partly deducible as corrollaries to them.

10. Pure distilled water, rain and spring water usually contain nearly their due share of atmospheric air: if not, they quickly acquire that share by agitation in it, and lose any other gas they may be impregnated with. It is remarkable however that water by stagnation, in certain circumstances, loses part or all of its oxygen, notwithstanding its constant exposition to the atmosphere. This I have uniformly found to be the case in my large wooden pneumatic trough, containing about 8 gallons, or $1\frac{1}{3}$ cubic foot of water. Whenever this is replenished with tolerably pure rain water, it contains its share of atmospheric air; but in process of time it becomes deficient of oxygen:

water is not present the *nitric* acid is formed which requires just half the quantity of nitrous gas, as I have lately ascertained.

In three months the whole surface has been covered with a pellicle, and no oxygenous gas whatever was found in the water. It was grown offensive, but not extremely so; it had not been contaminated with any material portion of metallic or sulphureous mixtures, or any other article to which the effect could be ascribed.* The quantity of azotic gas is not materially diminished by stagnation, if at all.—These circumstances, not being duly noticed, have been the source of great diversity in the results of different philosophers upon the quantity and quality of atmospheric air in water. By article 4, it appears that atmospheric air expelled from water ought to have 38 per cent. oxygen; whereas by this article air may be expelled from water that shall contain from 38 to 0 per cent. of oxygen.—The disappearance of oxygenous gas in water, I presume, must be owing to some impurities in the water which combine with the oxygen. Pure rain water that had stood more than a year in an earthenware bottle had lost none of its oxygen.

11. If water free from air be agitated with a small portion of atmospheric air (as $\frac{1}{15}$ of its bulk) the residuum of such air will have proportionally less oxygen than the original: If

* It was drawn from a leaden cistern.

we take $\frac{1}{17}$, as above, then the residuum will have only 17 per cent. oxygen; agreeably to the principle established in article 4. This circumstance accounts for the observations made by Dr. Priestley, and Mr. William Henry, that water absorbs oxygen in preference to azot.

12. If a tall glass vessel, containing a small portion of gas be inverted into a deep trough of water and the gas thus confined by the glass and the water be briskly agitated, it will gradually disappear.

It is a wonder that Dr. Priestly, who seems to have been the first to notice this fact, should have made any difficulty of it;—the loss of gas has evidently a mechanical cause; the agitation divides the air into an infinite number of minute bubbles which may be seen pervading the whole water; these are successively driven out from under the margin of the glass into the trough, and so escape.

13. If old stagnant water be in the trough, in the last experiment, and atmospheric air be the subject, the oxygenous gas will very soon be almost wholly extracted and leave a residuum of azotic gas; but if the water be fully impregnated with atmospheric air at the beginning, the residuary gas examined at any time will be pure atmospheric air.

14. If any gas not containing either azotic or oxygenous gas, be agitated over water containing atmospheric air, the residuum will be found to contain both azotic and oxygenous gas.

15. Let a quantity of water contain equal portions of any two or more unequally absorbable gases: For instance, azotic gas, oxygenous gas and carbonic acid gas; then, let the water be boiled or subjected to the air-pump, and it will be found that unequal portions of the gases will be expelled. The azotic will be the greatest part, the oxygenous next, and the carbonic acid will be the least.—For, the previous impregnation being such as is due to atmospheres of the following relative forces nearly;

Azotic —— 21 inch. of mercury
Oxygenous — 9————
Carbonic acid $\frac{1}{3}$————

consequently, when those forces are removed, the resiliency of the azotic gas will be the greatest, and that of the carbonic acid the least; the last will even be so small as not to overcome the cohesion of the water without violent agitation.

Remarks on the Authority of the preceding Facts.

In order to give the chain of facts as distinct as possible, I have not hitherto mentioned by whom or in what manner they were ascertained.

The fact mentioned in the first article has been long known; a doubt, however, remained rsspecting the quantity of air still left in water after ebullition and the operation of the air-pump. The subsequent articles will, I apprehend, have placed this in a clearer point of view.

In determining the quantity of gases absorbed, I had the result of Mr. William Henry's experience on the subject before me, an account of which has been published in the Philosophical Transactions for 1803. By the reciprocal communications since, we have been enabled to bring the results of our Experiments to a near agreement; as the quantities he has given in his appendix to that paper nearly accord with those I have stated in the second article. In my Experiments with the less absorbable gases, or those of the 2d, 3d, and 4th classes, I used a phial holding 2700 grains of water, having a very accurately

ground-stopper; in those with the more absorbable of the first class, I used an Eudiometer tube properly graduated and of aperture so as to be covered with the end of a finger. This was filled with the gas and a small portion expelled by introducing a solid body under water; the quantity being noticed by the quantity of water that entered on withdrawing the solid body, the finger was applied to the end and the water within agitated; then removing the finger for a moment under water, an additional quantity of water entered, and the agitation was repeated till no more water would enter, when the quantity and quality of the residuary gas was examined. In fact water could never be made to take its bulk of any gas by this procedure; but if it took $\frac{9}{10}$, or any other part, and the residuary gas was $\frac{9}{10}$ pure, then it was inferred that water would take its bulk of that gas. The principle was the same in using the phial; only a small quantity of the gas was admitted, and the agitation was longer.

There are two very important facts contained in the second article. The first is, that the quantity of gas absorbed is as the density or pressure.—This was dicovered by Mr. Wm. Henry, before either he or I had formed any theory on the subject.

The other is, that the density of the gas in the water has a special relation to that out of the water, the distance of the particles within being always some multiple of that without:—Thus, in the case of carbonic acid, &c. the distance within and without is the same, or the gas within the water is of the same density as without; in olefiant gas the distance of the particles in the water is twice that without; in oxygenous gas, &c. the distance is just three times as great within as without; and in azotic, &c. it is four times. This fact was the result of my own enquiry. The former of these, I think, decides the effect to be mechanical; and the latter seems to point to the principle on which the equilibrium is adjusted.

The facts noticed in the 4th, 5th and 6th articles, were investigated *à priori* from the mechanical hypothesis, and the notion of the distinct agency of elastic fluids when mixed together. The results were found entirely to agree with both, or as nearly as could be expected from experiments of such nature.

The facts mentioned in the 7th article, are of great importance in a theoretic view; for, f the quantity of gas absorbed depend upon mechanical principles, it cannot be affected by temperature in confined air, as the mecha-

nical effect of the external and internal air are alike increased by heat, and the density not at all affected in those circumstances. I have tried the experiments in a considerable variety of temperature without perceiving any deviation from the principle. It deserves further attention.

If water be, as pointed out by this essay, a mere receptacle of gases, it cannot affect their affinities: hence what is observed in the 8th article is too obvious to need explanation.—And if we find the absorption of gases to arise not from a chemical but a mechanical cause, it may be expected that all liquids having an equal fluidity with water, will absorb like portions of gas. In several liquids I have tried no perceptible difference has been found; but this deserves further investigation.

After what has been observed, it seems unnecessary to add any explanation of the 10th and following articles.

Theory of the Absorption of Gases by Water, &c.

From the facts developed in the preceding articles, the following theory of the absorption of gases by water seems deducible.

1. All gases that enter into water and other liquids by means of pressure, and are wholly disengaged again by the removal of that pressure, are *mechanically* mixed with the liquid, and not *chemically* combined with it.

2. Gases so mixed with water, &c. retain their elasticity or repulsive power amongst their own particles, just the same in the water as out of it, the intervening water having no other influence in this respect than a mere vacuum.

3. Each gas is retained in water by the pressure of gas of its own kind incumbent on its surface abstractedly considered, no other gas with which it may be mixed having any permanent influence in this respect.

4. When water has absorbed its bulk of carbonic acid gas, &c. the gas does not press on the water at all, but presses on the containing vessel just as if no water were in.—When water has absorbed its proper quantity of oxygenous gas, &c. that is, $\frac{1}{21}$ of its bulk, the exterior gas presses on the surface of the water with $\frac{26}{27}$ of its force, and on the internal gas with $\frac{1}{27}$ of its force, which force presses upon the containing vessel and not on the water. With azotic and hydrogenous gas the proportions are $\frac{63}{64}$ and $\frac{1}{64}$ respectively. When water contains no gas, its surface must support

the whole pressure of any gas admitted to it, till the gas has, in part, forced its way into the water.

5. A particle of gas pressing on the surface of water is analogous to a single shot pressing upon the summit of a square pile of them. As the shot distributes its pressure equally amongst all the individuals forming the lowest stratum of the pile, so the particle of gas distributes its pressure equally amongst every successive horizontal stratum of particles of water downwards till it reaches the sphere of influence of another particle of gas. For instance; let any gas press with a given force on the surface of water, and let the distance of the particles of gas from each other be to those of water as 10 to 1; then each particle of gas must divide its force equally amongst 100 particles of water, as follows:—It exerts its immediate force upon 4 particles of water; those 4 press upon 9, the 9 upon 16, and so on according to the order of square numbers, till 100 particles of water have the force distributed amongst them; and in the same stratum each square of 100, having its incumbent particle of gas, the water below this stratum is uniformly pressed by the gas, and consequently has not its equilibrium disturbed by that pressure.

When water has absorbed $\frac{1}{20}$ of its bulk of

1. All gases that enter into water and other liquids by means of pressure, and are wholly disengaged again by the removal of that pressure, are *mechanically* mixed with the liquid, and not *chemically* combined with it.

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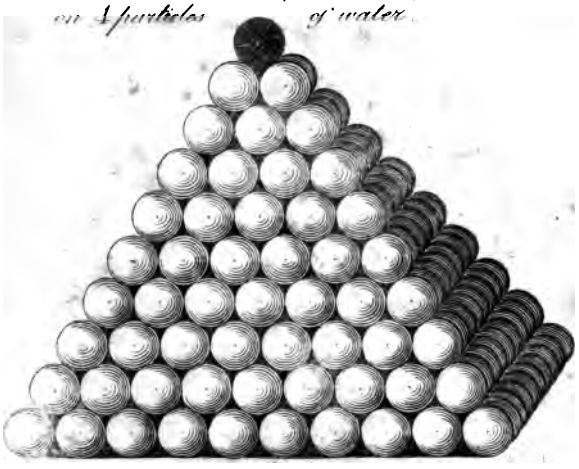
the whole pressure of any gas admitted to it, till the gas has, in part, forced its way into the water.

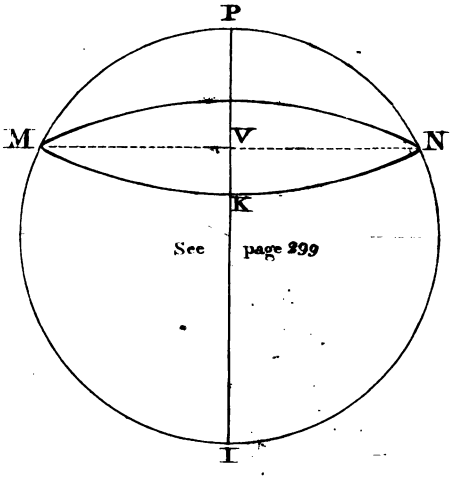
5. A particle of gas pressing on the surface of water is analogous to a single shot pressing upon the summit of a square pile of them. As the shot distributes its pressure equally amongst all the individuals forming the lowest stratum of the pile, so the particle of gas distributes its pressure equally amongst every successive horizontal stratum of particles of water downwards till it reaches the sphere of influence of another particle of gas. For instance; let any gas press with a given force on the surface of water, and let the distance of the particles of gas from each other be to those of water as 10 to 1; then each particle of gas must divide its force equally amongst 100 particles of water, as follows:—It exerts its immediate force upon 4 particles of water; those 4 press upon 9, the 9 upon 16, and so on according to the order of square numbers, till 100 particles of water have the force distributed amongst them; and in the same stratum each square of 100, having its incumbent particle of gas, the water below this stratum is uniformly pressed by the gas, and consequently has not its equilibrium disturbed by that pressure.

When water has absorbed $\frac{1}{25}$ of its bulk of

VIEW of a SQUARE PILE of SHOT &c

The lower globes are to represent particles of water; the top globe represents a particle of air resting on 4 particles of water.

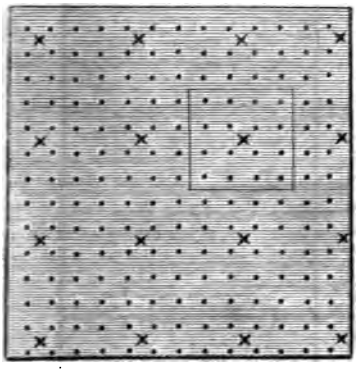




See page 299

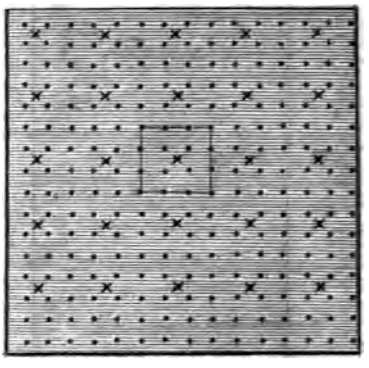
HORIZONTAL VIEW of AIR & WATER.

Incumbent Stratum of Atmosphere,
particles marked thus •
A Stratum of Air in the Water,
particles marked thus ×



Distance of particles 4 to 1

Azotic & Hydrogeneous gas.

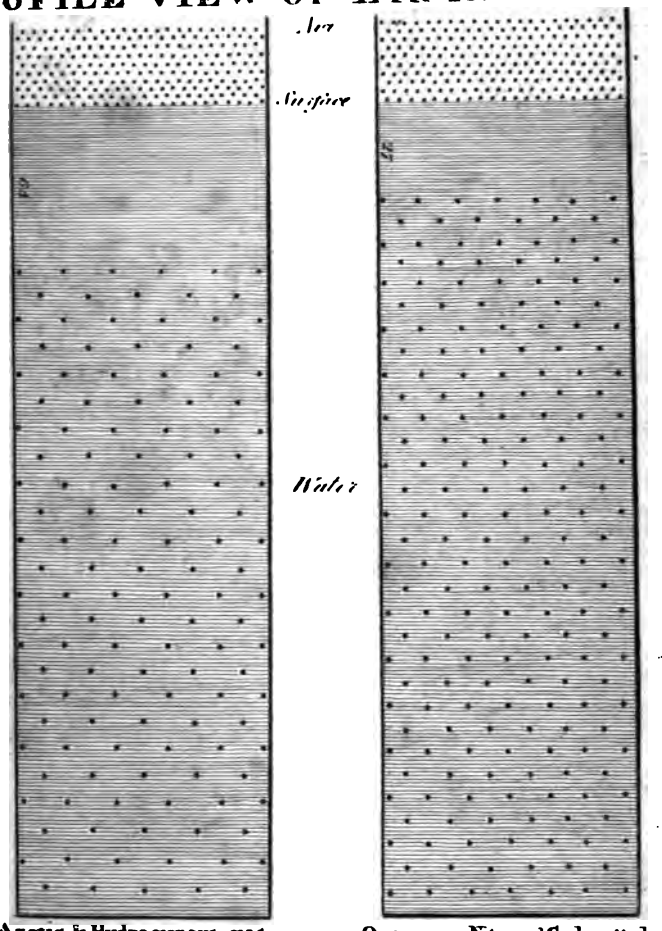


Distance of particles 3 to 1

Oxygenous, Nitrous & Carbonetted Hydrogen gas

Vol. I. Pl 3. to face Pl. 2

PROFILE VIEW OF AIR IN WATER



Azotic & Hydrogenous gas. $\frac{1}{64}$ Density

Oxygenous, Nitrous & Carburetted Hydrogen gas $\frac{1}{27}$ Density

any gas, the stratum of gas on the surface of the water presses with $\frac{26}{27}$ of its force on the water, in the manner pointed out in the last article, and with $\frac{1}{27}$ of its force on the uppermost stratum of gas in the water: The distance of the two strata of gas must be nearly 27 times the distance of the particles in the incumbent atmosphere and 9 times the distance of the particles in the water. This comparatively great distance of the inner and outer atmosphere arises from the great repulsive power of the latter, on account of its superior density, or its presenting 9 particles of surface to the other 1. When $\frac{1}{64}$ is absorbed the distance of the atmospheres becomes 64 times the distance of two particles in the outer, or 16 times that of the inner. The annexed views of perpendicular and horizontal strata of gas in and out of water, will sufficiently illustrate these positions.

7. An equilibrium between the outer and inner atmospheres can be established in no other circumstance than that of the distance of the particles of one atmosphere being the same or some multiple of that of the other; and it is probable the multiple cannot be more than 4. For in this case the distance of the inner and outer atmospheres is such as to make the perpendicular force of each particle of the former

on those particles of the latter that are immediately subject to its influence, physically speaking, equal; and the same may be observed of the small lateral force.

8. The greatest difficulty attending the mechanical hypothesis, arises from different gases observing different laws. Why does water not admit its bulk of every kind of gas alike?—This question I have duly considered, and though I am not yet able to satisfy myself completely, I am nearly persuaded that the circumstance depends upon the weight and number of the ultimate particles of the several gases: Those whose particles are lightest and single being least absorbable and the others more according as they increase in weight and complexity.* An enquiry into the relative weights of the ultimate particles of bodies is a subject, as far as I know, entirely new: I have lately been prosecuting this enquiry with remarkable success. The principle cannot be entered upon in this paper; but I shall just subjoin the results, as far as they appear to be ascertained by my experiments.

* Subsequent experience renders this conjecture less probable.

which is used in the experiment; for heat increases the pliancy of the substance, and cold, on the contrary, renders it more rigid; so that when a slip of this resin has been sufficiently warmed, it may be extended to more than twice its natural length, by a moderate force applied to its extremities, after which it will recover its original dimensions in a moment, provided one of the ends of it be let go as soon as it has been stretched. This disposition of the substance may be produced by a degree of temperature, less than the heat of the blood; it is therefore necessary to prepare a slip of it, by steeping it for a few minutes in warm water, or by holding it somewhat longer in the fist; either of these precautions makes the resin pliant, and fits it for the experiment; which is performed in the following manner.

I made a piece of Caoutchouc a little heavier than an equal bulk of water, the temperature of which was 45 degrees: the vessel containing the resin and water was then placed on the fire; and when the contents of it were heated to 130 degrees, the Caoutchouc floated on the surface.

A DESCRIPTION

of a Property of

CAOUTCHOUC,

or Indian Rubber;

With some Reflections on the Cause of the Elasticity of this Substance.

IN A LETTER TO DR. HOLME.

Read February 11, 1803.

SIR,

Middleshaw, near Kendal, Nov. 26, 1802.

THE substance called Caoutchouc, or Indian Rubber, possesses a singular property; which, I believe, has never been taken notice of in print, at least by any English writer; the present letter contains my experiments and reflections on the subject; and should they appear to deserve the attention of your philosophical friends, I am certain you will take the trouble of communicating the paper to the Literary and Philosophical Society of Manchester.

The property I am about to describe, depends on the temperature of the Caoutchouc,

which is used in the experiment; for heat increases the pliancy of the substance, and cold, on the contrary, renders it more rigid; so that when a slip of this resin has been sufficiently warmed, it may be extended to more than twice its natural length, by a moderate force applied to its extremities, after which it will recover its original dimensions in a moment, provided one of the ends of it be let go as soon as it has been stretched. This disposition of the substance may be produced by a degree of temperature, less than the heat of the blood; it is therefore necessary to prepare a slip of it, by steeping it for a few minutes in warm water, or by holding it somewhat longer in the fist; either of these precautions makes the resin pliant, and fits it for the experiment; which is performed in the following manner.

I made a piece of Caoutchouc a little heavier than an equal bulk of water, the temperature of which was 45 degrees: the vessel containing the resin and water was then placed on the fire; and when the contents of it were heated to 130 degrees, the Caoutchouc floated on the surface.

EXPERIMENT 1.

Hold one end of the slip, thus prepared, between the thumb and fore-finger of each hand; bring the middle of the piece into slight contact with the edges of the lips; taking care to keep it straight at the time, but not to stretch it much beyond its natural length: after taking these preparatory steps, extend the slip suddenly; and you will immediately perceive a sensation of warmth in that part of the mouth which touches it, arising from an augmentation of temperature in the Caoutchouc: for this resin evidently grows warmer the further it is extended; and the edges of the lips possess a high degree of sensibility, which enables them to discover these changes with greater facility than other parts of the body. The increase of temperature, which is perceived upon extending a piece of Caoutchouc, may be destroyed in an instant, by permitting the slip to contract again; which it will do quickly by virtue of its own spring, as oft as the streching force ceases to act as soon as it has been fully exerted. Perhaps it will be said, that the preceding experiment is conducted in a negligent manner; that a person, who wishes

for accuracy, will not trust his own sense of feeling in inquiries of this description, but will contrive to employ a Thermometer in the business. Should the objection be started, the answer to it is obvious; for the experiment in its present state demonstrates the reality of a singular fact; by convincing that sense, which is the only direct judge in the case, that the temperature of a piece of Caoutchouc may be changed, by compelling it to change its dimensions. The use of a Thermometer determines the relative magnitudes of these variations, by referring the question of temperature to the eye; experiments of this sort are therefore of a mathematical nature, and afford a kind of knowledge with which we have nothing to do at present; for we are not inquiring after proportions, but endeavouring to establish the certainty of a fact, which may assist in discovering the reason of the uncommon elasticity observable in Caoutchouc. My essay or letter appears to be running into a long digression; the subject must therefore be resumed, and it will not be improper to premise the following simple experiment, in the present state of the inquiry; because it seems capable of affording no inconsiderable degree of insight into the plan, which nature

pursues in producing the phenomenon in question.

EXPERIMENT 2.

If one end of a slip of Caoutchouc be fastened to a rod of metal or wood, and a weight be fixed to the other extremity, in order to keep it in a vertical position; the thong will be found to become shorter with heat and longer with cold. The processes of heating, cooling, and measuring bodies are so well known, that I need not enter into the minuter parts of the experiment; it will be proper however to add, that an increase of temperature diminishes the specific gravity of the Indian Rubber, and a loss of heat occasions a contrary effect in it; as I have proved experimentally. The knowledge of the latter fact leads me to conclude, apparently on reasonable grounds, that the pores or interstices of Caoutchouc are enlarged by heat, and diminished by cold; consequently when a slip of this substance which remains extended by a weight, or the application of force, happens to contract from an accession of temperature, the capacity of its pores, taken separately or collectively, is augmented by the change that

takes place in the figure of the thong. Now if the existence of caloric be admitted, it will follow from the preceding arguments, that the phenomenon under consideration is occasioned by the alternate absorption and emission of the calorific fluid, in the same manner that ropes, the blades of Fuci, as well as many more bodies, are obliged to contract and extend themselves, by the alternate absorption and emission of water.—You will perceive by the tenour of the foregoing observations, that my theory of this case of elasticity is perfectly mechanical; in fact, the explanation of it depends upon the mutual attraction of Caloric and Caoutchouc; the former of which penetrates the latter, and pervades every part of it with the greatest ease and expedition; by which the resin is compelled to accommodate its pores to that portion of the Calorific fluid which is due to its whole mass, at any particular degree of temperature. In order to apply the last remark to the phenomenon under consideration I may observe, that if a force be exerted on a piece of Caoutchouc to alter the dimensions of its pores, the mutual attraction mentioned above will resist the effort. But the ease with which this substance may be made to change its figure, and the retractile power which it possesses on these occasions, shew that

its constituent particles move freely amongst themselves: but where there is motion, there is void space; consequently Caoutchouc abounds with innumerable pores or interstices, the magnitudes of which are variable, because the specific gravity of the resin becomes less with heat, and greater with cold. Now if the dimensions of the pores in a piece of Caoutchouc can be lessened, without taking away part of the matter of heat, which it contains at the time; this new arrangement in the internal structure of the slip will lessen its capacity for the matter of heat, and consequently augment its temperature. But the warmth of such a slip is increased by stretching it, according to the first experiment; the pores of it are therefore diminished; and the effort, which it exerts at the time, arises from the mutual attraction of the Caoutchouc and Caloric; which attraction causes an endeavour to enlarge the interstices of the former for the reception of the latter; hence it happens that the thong contracts longitudinally, according to the second experiment, and the redundant caloric is absorbed in the course of this operation, which again reduces the temperature. The preceding explanation agrees very well with the phenomenon, as i is stated in the beginning of this letter; and the

theory receives additional confirmation from the following facts.

EXPERIMENT 3.

If a thong of Caoutchouc be stretched, in water warmer than itself, it retains its elasticity unimpaired; on the contrary, if the experiment be made in water colder than itself, it loses part of its retractile power, being unable to recover its former figure; but let the thong be placed in hot water, while it remains extended for want of spring, and the heat will immediately make it contract briskly. The foregoing circumstances may be considered as proving, that the elasticity of Caoutchouc is not a constitutional quality of the substance, but a contingent effect, arising from the loss of equilibrium between the portion of caloric, which the resen happens to contain at any moment, and its capacity to receive that fluid at the same instant. The object of the present letter is to demonstrate, that the faculty of this body to absorb the calorific principle, may be lessened, by forcibly diminishing the magnitudes of its pores; and this essential point of the theory may be confirmed by experiment: for the specific gravity of a slip of Caoutchouc is increased, by keeping it extended, while it is weighed in water.

JOHN GOUGH.

AN ESSAY

ON THE

THEORY OF MIXED GASES,

AND THE

STATE OF WATER IN THE ATMOSPHERE.

BY

MR. JOHN GOUGH.

COMMUNICATED BY DR. HOLME.

Read Nov. 4, 1803.

FOUR essays appear in the fifth volume of the Memoirs of the Literary and Philosophical Society of Manchester, which contain many new ideas relating to the constitution of mixed gases, and the state of water in the atmosphere. The design of these papers is evidently intended to remove certain difficulties which must strike every man of science, who happens to peruse M. de Luc's theory of atmospherical vapour. This attempt has the double recommendation of ingenuity and noveltv; but the leading opinions of the system, even in its present form, are liable to several objections, which I am going to point out, being generously invited to undertake the

task, by the author himself. My doubts relative to the subject arise partly from mathematical considerations, and in part from the evidence of experiment. Certain objections of the first class dispose me to conclude, that an atmosphere constructed on Mr. Dalton's plan, will appear upon examination to be repugnant to the principles of the mechanical philosophy; and a direct appeal to experiment has moreover convinced me, that well established facts contradict the essential points of the theory.

To begin with the objections of the former class: I am ready to admit the existence of a fluid mixture, such as we find described at page 543, in the fifth volume of the Manchester Memoirs, with this reservation, that the concession is made, merely for the purpose of shewing such a combination to be incompatible with the usual course of things, for a moment; which being demonstrated, the inutility of the fundamental hypothesis will follow, as a necessary consequence. — To give a concise view of Mr. Dalton's general notion of the subject, we are to suppose a number of distinct gases to be confined in a space common to them all; which space may be circumscribed by the concave surface of a vessel, or the compressing power of an external fluid:

besides this we must imagine the constituent particles of each individual gas to be actuated by a mutual repulsion, while at the same time they remain perfectly indifferent to the particles which compose the other fluids that are confined in the common space; in short we are to conceive, that the particles of each gas act upon those of their own kind in the manner of elastic bodies; but that they obey the laws of inelastic bodies, as often as they interfere with corpuscles of a different denomination. After premising the preceding particulars, we may conceive a certain arrangement of the elementary parts of a fluid mixture, in which the adjustment of the whole shall be of a description, which will form from particles of any one denomination, a homogeneous fluid, possessing its own separate equilibrium; consequently each gas will exist as an independent being, and exercise the functions of its elasticity, just as if all the other fluids were withdrawn from the common space. This systematic arrangement in an assemblage of gaseous substances cannot be maintained, unless one particular method of disposing its component parts be observed; which consists in that distribution of the elements which will produce a separate equilibrium in the fluid composed by the elementary corpuscles of each denomination;

consequently the equilibrium in question cannot take place unless the necessary disposition of the heterogeneous particles be first established; so that the former requisite of the theory is entirely depended on the latter.—After having acquired a distinct idea of a fluid mixture, composed of gases possessing separate equilibria, we come in the next place to investigate the mechanical properties of such a compound; in the prosecution of which enquiry, the comparative densities of the constituent fluids must be first determined in a horizontal plane, the situation of which is given in the common space.

Let the figure PMINKV represent this space, in which MVNK is the given plane.—Now since every point of this plane may be supposed to be at an equal distance from the earth's centre, the density of every homogeneous gas supported by it, will be the same in all parts of it. Let the constituent fluids be denominated A and B; also let C denote the compound; moreover let the densities of A and B, at P, be p and q; let PX and XY be two equal evanescent parts of the line PV. Now seeing the pressure acting upon an elastic fluid is as the density of it, the fluxionary increments of p and q, are as these quantities; but the densities of A and B, in the point X, are

equal to the sums of p and q united to their increments respectively; let these sums be called e and f; then e is to f as p is to q, by composition of proportion: in like manner we find the density of A at Y to be to that of B at the same point as e is to f; i. e. as p is to q; thence it follows, that the fluxionary increments of the two densities have universally the given ratio of p to q; consequently the contemporary fluents, or the densities themselves have the same given ratio: now what has been proved of the two gases A and B may be extended to any other number; viz. the ratios of their densities, on the same horizontal plane will be given.

The ratio of A B, &c. being found to be constant, we can proceed to investigate the proportions of the quantities of matter contained in these fluids. Let D and d be the densities of A and B, in the plane MKNV; also let W and w be the quantities of matter of each kind, contained in the variable space PMKNV; call PV x, and the area of the plane MKNV y: now the fluxion of the space PMKNV is expressed by y into the fluxion of x; moreover the quantities of matter in two solids are in the complicate ratios of their magnitudes and densities or in that of the densities only, if their magnitudes be equal;

therefore the fluxion of W is to that of w as D is to d; because the fluxionary magnitude is common both to W and w; but D is to d as p to q, a constant ratio; consequently fluxion of W is to fluxion of w as p is to q; therefore W has to w the same given ratio; that is, the matter in A is to the matter in B as p is to q. In the next place let R and r be the distances of the centres of gravity of A and B, from the point P, taken in the line PI: then R into the fluxion of W is equal to the product of D, Y, x, and the fluxion of x, from a well known theorem in mechanics; for the same reason r into the fluxion of w is equal to the product of d, y, x and fluxion x; hence R into fluxion of W is to r into fluxion of w; as D is to d; but D is to d, as fluxion of W is to fluxion w; therefore R and r are equal: consequently the centres of gravity of A and B coincide, and the point of their coincidence is also the centre of the system C. Thus it appears, that when the component gases of a fluid mixture posses separate equilibria, their densities are every where in a given ratio; and they have a common centre of gravity: the converse of which is equally true; viz. if their densities be not every where in a given ratio, and if they have not a common centre of gravity, they do not possess separate equilibria.

It is necessary to observe in this stage of the inquiry, that though we admit the particles of A and B to be inelastic in relation to each other, the concession must be strictly confined to the particles themselves; for the gases which are composed of them are elastic bodies; they therefore receive and communicate motion according to the laws which are peculiar to bodies of this description.—The foregoing properties of a fluid mixture, which has been supposed to be duly adjusted, is now to be used in the examination of the fundamental proposition of the new theory intended to explain the constitution of the atmosphere. According to this proposition, if two gases come into contact the particles of which are perfectly inelastic in respect of each other, the particles of A meeting with no repulsion from thofe of B, further than that repulsion, which as obstacles in the way they may exert, would instantly recede from each other, as far as possible in their circumstances, and consequently arrange themselves, just as in a void space. The preceding are the words of the author of the theory; and it is readily granted that the particles of such a heterogeneous mixture would recede from each other as far as circumstances will permit; the present subject of inquiry then brings the dispute to this issue; can that arrangement take

place amongst the particles of two or more gases, which will make their centres of gravity coincide in one point?—For the separate equilibria of the fluids, which enter into the constitution of the compound, will not be established until this arrangement be perfectly formed. The completion of this process being essential to the new theory, the effect of it has been, perhaps, too hastily inferred in the fourth proposition of Mr. Dalton's first essay; for I am sorry to observe, that the inference is not supported by demonstration, drawn from the doctrine of mechanics. It is the business of the present essay to supply what has been omitted, and to investigate the consequences which must arise from the collision of two heterogeneous gases, differing in their specific gravities.

The existence of the fluid mixture, required by the theory, has been granted already, for the sake of argument; and in order to continue the enquiry, it must be remarked at present, that the necessary internal arrangement of the compound C, is liable to be disturbed perpetually by accidents resulting from the course of things; to which course the author of the theory undoubtedly wishes to accommodate his ideas. The preceding assertion may be exemplified in a manner which is familiar, and

may be applied with ease to natural phenomena: let us suppose then an additional quantity of the gas A to be thrown into the pneumatic apparatus, containing the compound C, which was in a state of proper adjustment previous to this event. No one will imagine, that this fresh matter can diffuse itself through the mass of C with the same expedition that the electric fluid shews in expanding along a conductor: this supposition is contradicted by various appearances, from which the following one is selected; agitation is known to accelerate the union of oxygen and nitrous gas. The quantity of A then, which has been newly admitted, will remain at first unmixed with B; but it will act immediately with a repulsive force upon kindred particles diffused through the compound C. This new modification of A will not preserve the density of its parts every where in a constant ratio, to the density of the corresponding parts of B; and this change will disjoin the centres of gravity of A and B; which has been proved above. But when these points are placed apart, the separate equilibria of the fluids cease to exist, which has also been demonstrated before; therefore A and B begin to act and react mutually; which circumstance disturbs the necessary adjustment of C, and forces it

to assume another character. It has also been proved in a former paragraph, that the two fluids will act upon each other in the manner of elastic bodies, even when the heterogeneous particles are supposed to be mutually inelastic; consequently A and B will begin to obey the the law of their specific gravities, as soon as their centres of gravity are separated by introducing into the space occupied by C, a fresh quantity of A or B: in consequence of this alteration the centre of gravity of the heavier fluid will begin to descend while that of the lighter moves upwards. When once the centres of two gases are placed apart their separation will become permanent; because when at a distance they are urged in opposite directions by a force resulting from the difference of the specific weights of the two fluids; and this contrariety of efforts must continue so long as the two centres are disjoined; consequently this opposition of force must be lasting; seeing nothing can put an end to it but an union, which it will always prevent. Nor can the mutual repulsion of the constituent particles of each gas considered apart, in any manner promote the junction of the centres of gravity of the two fluids, because the action and reaction of a number of bodies amongst themselves do not alter the state of their com-

mon centre of gravity, whether it be at rest or in motion: so that A and B are under the necessity of observing the law of their specific gravities, just as if the kindred particles of each fluid were actuated by no reciprocal repulsion nor any other cause of reaction. The doctrine of gases, which are mutually inelastic, is rendered indefensible by the preceding arguments; for the hypothesis is thereby exposed to a difficulty which the author of the theory justly remarks, makes a mixture of mutually repulsive gases of different specific gravities an improbable conjecture; so that his own objection ultimately discountenances the leading opinions of that theory which it induced him to adopt in particular. At the same time, philosophers are convinced that the atmosphere is a compound of gases, possessing various degrees of specific weight: they moreover know that different chemical agents perpetually disturb the equilibrium of the compound, as some of them constantly absorb while others unfold the gases of which it is composed. The preceding facts are certain; consequently the heterogeneous elements of the atmosphere must be united by a common tie, which may be denominated a species of affinity, at least while our knowledge of the subject remains in its present imperfect state. The transparency of the great

body of air surrounding the earth, also affords a strong argument for the chemical union of its component fluids; and at the same time discountenances the idea of the compound being a mechanical mixture of any description whatever: for when a number of diaphanous bodies of different specific gravities are mixed together, they form an aggregate which is opaque; but the union of the substances by fusion renders the mass transparent in many instances. Now as the atmosphere is diaphanous, we are obliged by the principles of sound argument to consider it in the light of a compound, the ingredients of which are united by a chemical tie.—Whatever may be the condition of the elastic fluids which enter into the composition of common air, one thing is certain from a preceding paragraph of this essay; namely, no one of them can maintain a separate equilibrium as long as it makes an individual of the aggregate; consequently each particle of the compound must be urged by a force resulting from the general action of the mass, not by a pressure occasioned by a particular member of it.

On this account it is impossible for the aqueous part of common air to preserve the character of a gas at low temperatures; because steam cannot support 30 inches of mercury

unless it is heated to 212 degrees of Farenheit's thermometer; were it then practicable to mix vapour of a less heat with atmospherical air the spring of the gases would reduce it in an instant to the state of a liquid; so that the difficulty, which renders De Luc's theory objectionable in its original form, is not removed in reality by the present modification of it.

The theory of mixed gases has been found to be indefensible on the principles of the mechanical philosophy; and I suspect that part of it which relates to the separate existence of vapour in the atmosphere, will prove equally unfortunate when brought to the test of experiment. Mr. Dalton, in all probability, supposed he had done all that the confirmation of this theory required, by inventing the doctrine of separate equilibria; for nothing more has been offered in support of his opinions, particularly of that relating to the existence of uncombined vapour pervading the atmosphere, unless the statement of the following experiment with his explanation of it may be referred to this head. If two parcels of dry air, which are equal in bulk, density and temperature, be confined by equal columns of mercury, in two tubes of equal bores, one of which is wet and the other dry; the air, which is thus exposed to water, will expand more than that which is kept dry,

provided the corresponding augmentations of their temperatures be equal; which phenomenon is thus explained on the principles of the theory. The vapour that arises from the sides of the wet tube, possesses a spring of its own; therefore it takes off part of the weight of the mercury from the air, and thereby leaves it to expand itself, so as to re-adjust the equilibrium. According to this explanation, if l and g represent the lengths of the columns of dry and moist air at any temperature; and if c denote the length of a column of mercury, equal in weight to the pressure that confines the contents of the tubes; and if f be put for the spring of vapour of the same temperature measured by a column of mercury, we have

$g=\frac{lc}{c-f}$; from which we also get $c=\frac{fg}{g-l}$

the last expression affords us an opportunity of comparing the preceding explanation, and therefore the theory itself with facts; for, according to the experiments of Mr. Schmidt, 1000 parts of dry air at 32 degrees of Farenheit, will expand to 1087,11 parts, by being raised to 59 degrees, in contact with water; call this number g; according to the same author, 1000 parts of dry air at 32 degrees will expand to 1053,61 parts, by being

heated to 59 degrees in a dry tube; let this number be l; then $g-l=33.50$: but f, or the spring of vapour at 59 degrees, is .507, according to Mr. Dalton; then $fg = 551,164$; hence $c = 16,15$ inches; which expresses the height of the barometer, together with the column of mercury contained in the tube. If the temperature be stated at 95 degrees, c will amount to little more than 8 inches: now it is highly improbable that Mr. Schmidt made his experiments when the barometer stood at a height indicated by either of these numbers.—This application of the theory to practice, affords a presumptive evidence that the principles of it are not altogether just, supposing the experiments of Mr. Dalton and Mr. Schmidt to be correct: but a positive proof of a want of accuracy in these principles may be obtained by introducing a small change into the manner of conducting the experiment made with moist air. This alteration consists in discarding the stopple of mercury, and substituting the simple pressure of the atmosphere in the room of it: because when this substance which is impenetrable to steam, has been removed, the redundant vapour will, according to the theory, flow into the atmosphere, thereby leaving the moist air of the tube to follow the law of expansion observed by

dry air. With a view to find whether this be the case or not, I filled a bottle with running water of the temperature of 59 degrees, which, when carefully poured out again, weighed 7794 grains. The bottle, having a dew left sticking to the sides of it, was placed in water at the temperature of 126 degrees: the mouth, which remained about an inch above the surface, was covered with my hand, care being taken to remove it frequently for an instant to permit the vapour and expanding air to escape. After keeping it in this situation about two minutes, I secured the mouth in the manner described above and inverted it in a quantity of the same water, where it was reduced to 59 degrees; in consequence of which it took up 1622 grains of water, leaving a space equivalent to 6172 grains. If the experiment be now inverted, 6172 parts of air will occupy the space of 7794 such parts when its temperature is raised from 59 to 126 degrees; which is nearly double the expansion of dry air in like circumstances. For according to Mr. Schmidt's experiments, 1000 parts of dry air of 59 degrees will become equal to 1133,03 such parts, by being heated to 126 degrees; therefore, by the rule of proportion, if 1000 parts give an expansion of 1133,03 such parts, 6172 parts give only 820: but the difference

of 7794 and 6172 is 1622, which is nearly the double of 820. The preceding experiment, and others which I have made of the same kind, demonstrate that moist air expands more than dry air under like circumstances, and the fact subverts the notion of uncombined elastic vapour mixing with the atmosphere. The accuracy of the fact may be disputed; the doubt however is removed by repeating the experiment: but so long as my statement remains uncontradicted, the consequences of it to the theory in question cannot be controverted by argument: for if elastic vapour mix with the air, it does more than merely enter the pores of this fluid; for according to my experiment, it enlarges these pores at low temperatures which we know to be impossible, unless the heat of the compound arises to 212 degrees. Those who are convinced of the superior expansion of moist air, will readily apply the principle to certain interesting phenomena, in particular to the origin of Tornadoes in hot countries, and the variation of the barometer in temperate climates.

Mr. Barrow, an intelligent traveller in South Africa observes, that the atmosphere in Caffraria is sometimes heated to 102 or 104 degrees: this is succeeded by local thunderstorms, attended with heavy falls of rain and

hail, as well as violent hurricanes. I do not pretend to assign the refrigerating cause, or the agent that produces precipitation in this case; I only have to observe, that the portion of air must lose much of its elasticity, which is suddenly cooled to 70 or 72 degrees, and at the same time parts with the water it held in solution. This partial diminution of spring will destroy the equilibrium of the adjacent parts of the atmosphere, and may be supposed to produce the tornadoes of the tropical regions. The same cause probably gives rise to the fluctuations of the barometer in milder climates: for though the changes of temperature are less in the milder than in the hottest parts of the globe, the agents that precipitate the water of the atmosphere, appear to act on a more extensive scale, and through a longer duration in the former situations than they do in the latter. Wet weather is neither momentary nor local in Europe; provinces, and even kingdoms are deluged with rain for weeks together. The air, which discharges such an abundance of water will lose part of its spring, according to Mr. Schmidt's experiments, even when it suffers no change of temperature: now it is evident that the equilibrium cannot be restored in an instant; because the diminished elasticity must be augmented in this case by currents of

air coming from remote places. The diminution of spring in the atmosphere is shewn by the fall of the barometer; and the subsequent ascent of the mercury indicates the arrival of the restorative currents. According to this explanation, the barometer will rise slowly but gradually in the centre of the rainy district, while the motions of it will be more rapid and less regular towards the verge of the storm. High winds will also prevail in wet seasons, which will blow towards the parts where the elastic force of the air is least; that is, where the rains are most abundant.—I know not what claim to originality is due to the foregoing hints towards the theory of the barometer; they have, however, the merit of being a natural consequence of an established fact; I mean the great dilatation of air saturated with moisture, which must undergo a proportionate contraction when deprived of water.

ON THE

USE OF THE SUTURES

IN THE

SKULLS OF ANIMALS.

BY

MR. B. GIBSON.

Read Dec. 1, 1803.

THE full use of the singular junction of the bones of the skull which is called Suture, has, from the earliest periods of anatomy and surgery, attracted the attention and eluded the researches of the physiologist. To this remarkable feature in osteogeny, in a great measure peculiar to a certain period of life, many uses have been attributed. Some of these are totally erroneous; such as that for allowing the transpiration of moisture, to keep the brain cool and fit for thinking; for giving a more strict adhesion of the *dura mater* to the inner surface of the skull; for admitting a more free communication by blood-vessels between the external and internal parts of the head; or for affording interstices, that the

bones may be pushed asunder by the growth of the brain, lest that organ should be cramped in its growth, in consequence of the comparatively slow growth of the bones of the skull.

Other uses attributed to the Sutures are merely slight advantages derived from their structure, which are enjoyed in early infancy, or till adult life, but gradually cease after that period. Thus at the time of birth the loose union of the bones of the skull accommodates the shape of the head to the figure of the different parts of the cavity through which it passes. At adult age, when the sutures are fully formed, they may occasionally check the progress (if I may be allowed the expression) of a fracture nearly spent;—or vibrations, communicated to the bones of the skull, will be propagated with less force to the brain, in consequence of the bones being separated at the sutures. It is, however, abundantly evident, that these are not the main purposes for which the sutures are formed; otherwise they would not begin to be obliterated at a period of life when they would perform these offices more usefully than ever. Consistent with this remark we shall find, that the true purpose for which they are formed, and the particular process with

which they are connected, is fully completed before their obliteration takes place.

When we take a view of the mode of junction between many bones, and parts of bones in the human body, which do not admit of motion, we find that with little exception they all agree in this particular; that sooner or later the cartilage or periosteum, which once was interposed is obliterated, and these different portions, or entire bones, coalesce.

The separate portions, which originally compose the vertebræ, are early in thus uniting: after these the sides of the lower jaw; at a later period the epiphysis of a cylindrical bone is united to its body: and still later the bones of the skull usually coalesce, and the sutures are obliterated. Other bones, as those of the face, which have no motion and sustain little weight, are irregular in this respect; sometimes uniting, but generally remaining distinct, to the end of a long life.

The original formation of the osseous system in several distinct pieces, respects principally its speedy ossification at an early period of life, and its future convenient extension, till it has arrived at its full growth; and we may consider it as a general principle, that where two parts of *one* bone are separated from each other by an intervening cartilage, or *two* distinct

bones merely by periosteum, at that part osseous materials are added to increase their length or extend their superficies. This we shall find takes place, whether the junction be effected by comparatively smooth surfaces, as between the body of a bone and its epiphysis; or between the bones of the skull by jagged sutures. Hence it appears that the bones of the body generally are increased in length or extent, not by a uniform extension of the whole substance, but by an addition of bony matter in some particular part.

Thus the body of a cylindrical bone is lengthened by addition to each end. This we might conclude would be the case from considering the part, in which its ossification commences: as this commences in a middle point and proceeds to each extremity, it is natural to suppose that its growth still goes on in the same direction, or continues at the extremities. That this is the case we know, not by reasoning alone, but by a direct experiment. Mr. Hunter sunk two small pieces of lead in the middle of the tibia, or shin bone of a pig, and measured accurately the distance between them: on examining the animal some time afterwards, it appeared, that though the bone had increased considerably in length, the

pieces of lead still remained at the same distance from each other that they were before. From this experiment we learn, that a cylindrical bone is not extended in its middle, but is lengthened by addition to its extremities, where the body of the bone is joined to its epiphysis; the chief intention of the epiphysis being to allow the intervention of a vascular organ, which may conveniently deposit bony materials, without interfering with the joint itself.

As cylindrical bones are lengthed at their extreme parts, we are led by analogy to conclude, that the same general plan is pursued in the extension of the flat bones of the body: and although we have no direct experiment by which this has been proved, there are circumstances which leave little doubt but they are extended by addition to their edges. Thus to take the parietal bone as an example; as ossification begins in a central point and extends towards the circumference, it is probable that to the completion of the process, it continues to go on in the same direction; and the same circumstance taking place in every bone of the cranium, it is probable, that even after the whole of the brain is incased in bone, the addition is still made at the edge of each, and that the general enlargement originates where

they are all mutually joined by the sutures. Of this process I had a very striking illustration some years ago. In a young subject, from what cause I know not, the deposition of osseous matter had been suddenly increased a short time before death. It was in different stages of progress, but had taken place in all the bones of the body which I preserved; in some partially, in others generally. In all, the new osseous matter was elevated above the level of the bone, upon which it was placed. In some parts of the parietal bones it was only in its commencement, and put on the appearance of a net-work, similar to that which may be observed in the same bones at an early period of their formation. In other parts the meshes of the net-work were more or less filled up; in others again completely, so as to put on the uniform appearance of solid bone. The same reticulated appearance was evident on the edges of all the bones of the skull, where they form the sutures, and at the extremities of the cylindrical bones, between the body and epiphysis. The same appearance of increased deposition was seen on the surface of the cylindrical bones, with this difference, that the meshes were not circular, but oblong squares; so as to put on more of the striated appearance. In some parts, the newly secreted

bone was easily separable from the general mass, and formed a thin layer externally, affording one of the best proofs I have met with, of the increase of cylindrical bones in thickness by deposition externally, whilst a corresponding internal absorption goes on. From the striking similarity of appearance on the surfaces and edges of the bones, we may safely conclude, that the same process of deposition was going on in both, and may thence infer, that the bones of the skull are increased in extent by the deposition of osseous matter at their edges, or where they are joined to each other by suture. This fact points out to us, in a great measure, the real use of this peculiar mode of junction.

In order that the bones of the skull may be increased in extent, it is necessary that they should be retained at a certain distance from each other; that the periosteum with its vessels may pass down between them, free from compression and secrete the osseous matter. At the same time, the thin bones composing the upper part of the skull, resting as an arch upon its basis, must be united together so firmly, as not to be separated by common degrees of violence. For this purpose, projecting points from the external surface of each bone, are reciprocally received into corresponding nitches;

which only penetrate through one half of the thinckness of the skull, and form an irregular kind of dovetailing.

Two advantages arise from this structure being superficial and confined to the external table of the skull. The projecting points from each side, resting upon the solid surface of the internal table of the opposite bone, can resist more effectually any violence, which might tend to force the bones inwards; and the internal part of the skull presents, by this means, a smooth surface to the coverings of the brain; for internally no appearance of a jagged suture is seen.

From this view of the subject we see, that the sutures of the human skull, by their peculiar formation, at once unite the bones together, and so far separate them, as to allow the interposition of a vascular organ by which their superficies is graduálly increased to its greatest extent.* This explanation of the use

* Since this paper was written in the year 1800, I have found, that a similar opinion was published by Professor Soemmerring in 1794, in his valuable work, "de corporis humani fabrica." To him, therefore, any credit which may belong to the primary suggestion of this use of the sutures is due. As his opinion, however, has been little noticed by anatomists generally, and is placed in a clearer point of view by the facts which suggested this further explantion

of sutures comprehends and accounts for those concomitant circumstances, which were considered by older anatomists as their real use; and as far as I can see, is not contradicted by any fact connected with them.

of it to me, it has not been thought improper to give this essay a place in these Memoirs. But whilst the reader will see, by the following quotation, the near resemblance between the opinion of Professor Soemmerring and that which I have brought forward, I hope the character of plagiarist or compiler will not be attributed to me.

" Usus horum sic sese habentium terminorum ossa cranii inter bene liquet.

" Incrementum ambitus calvariæ levant, ni enim inter " ossa capitis mox post partum suturæ interponerentur, " hæc crescere non possent, nisi aliâ ratione natura rem " instituerat. Tali igitur modo incrementum calvariæ " cum incremento reliquorum ossium convenit; initio enim " suturis, vel potius lineis cartilaginosis ossa iis locis con- " glutinantur, verum tamen non nisi in embrionibus ad " fonticulos, ut aiunt, hæc linea notabili latitudine, " observatur. Ossibus enim capitis hic locorum cerebro " crescente, placide quasi diductis, cartilago augetur, latior " evasura, nisi pristina pars simul in os mutaretur, inde " ossa calvariæ, eodem modo, quo ossa longa diductis " epiphysibus, vel quod unum idemque est, marginibus " crescere, liquet, etsi in ossibus, longis sutura epiphyses " inter et diaphysin non crispetur.

" Quo junior igitur infans, eo minus crispa et implexa " sutura, vel ut rectius loquar, linea cartilaginosa angusta, " ossa jungens, observatur. Quum vero aucta ætate ossa, " crescente cerebro, diducuntur, eorumque crassitudo, " adposita cum internæ, tum externæ potissimum tabulæ,

If it be asked, for instance, why at the sutures there is a stronger adhesion of the *dura mater* internally and *periosteum* externally than in other parts of the skull? the answer is, that these membranes with their vessels are continued into the sutures, to form conjointly the secretory organ, by which the bones are extended.

If it be asked, why there is a greater vascularity or an appearance of blood-vessels passing through the sutures? it is perfectly consistent with this opinion to answer, that the increase of blood goes to this secretory organ, for the purpose of the extension of the bones.

The explanation here offered, accounts also for the general obliteration of the sutures after a certain period of life; for the bones having then arrived at their full size, the organ for the secretion of osseous matter is no longer needed; it shrinks and is absorbed, and the bones gradually coalesce; by which a further ad-

" (internæ enim incrementum citius absolutum videtur) " massa ossea, augetur, non potest non esse, quia hæc " crispa suturæ forma, quum quidem nasci cœpit, externâ " in superficie tamdiu, augeatur, donec tandem ipsa ea " quam maxime impediat, quo minus cerebrum calvariam " ulterius diducere possit, quod pubertatis tempore accidit. " Rarissime hæc ossificatio ad ætatem virilem usque de- " tinetur."—Soemmerring de corporis Humani Fabrica, page 212.

vantage is derived, that of an accession of strength to the cranium at large.

If any additional argument be necessary in support of this opinion, I may also notice the striking analogy, which subsists between the separation of one bone of the skull from another by a suture; and that separation which exists between the body of a cylindrical bone and its epiphysis. They each remain only for a certain length of time; each allows the interposition of a secretory organ; and both begin to be obliterated, when the bones with which they are connected have completed their growth, and their continuance is no longer necessary.

ON THE

MORAL INFLUENCE

OF

HISTORY.

BY

THE REV. G. WALKER, F. R. S.

Read Feb. 24, 1804.

THE encomiums which history has received from writers of the first fame in every age, the high rank which it holds among the productions of human genius, and the general avidity with which it is read, are such arguments of intrinsic worth or interest, or both; that he must be hardy indeed who should throw down his gauntlet as the adversary of history. If such were my intention, it would argue a boldness approaching to immodesty, and would be a severe condemnation of my own conduct through life. In no form of literature have I felt a deeper interest; from few, if any, derived greater improvement; to none

devoted a greater portion of time. I should think it not extravagant to say, that I have with pleasure perused a million pages of history in the course of my literary life. It cannot therefore be supposed, that I mean to detract one iota from the real worth, importance, and interest of history. But, like the enraptured lover, the admirers of history may ascribe to her what she has no claim to, viz. that of being eminently the instructress of moral; and the questioning this supposed attribute is the sole object of the present essay.

This attribute has certainly been ascribed to history by writers of great repute, whose judgment on any subject ought not lightly to be arraigned. But

> Nullius addictus jurare in verba magistri—HOR.

is a maxim sanctioned by high authority, and essential to the freedom of the human mind.—The Jesuit Strada, Lord Bolingbroke, Vertot, Dr. Priestley, and many others, if my recollection do not fail me, have considered this praise, as appropriately due to history. But on what grounds I am utterly ignorant, for to the best of my remembrance they assume it as a datum, which they suppose no one would question. Perhaps it is presumed from the general interest and acceptance of history

in every age. Perhaps it is inferred from such logical reasoning as the following. If moral be founded in the nature of man, this moral must be best learned from the largest and most comprehensive view of man; and this view of man, it is presumed, can only be found in history. Every part of this reasoning is sound but one, viz. that history is this large and comprehensive view of man. While if history be but a very partial view of man, of one distinct class of man, and this the most vicious and depraved class, and therefore history be generally the record of the vices, and hardly at all of the virtues of man; and in addition to this narrow and partial view, if moral be not the object of history, the inference will totally fail, and so far as the information of history goes, we may be led to think infinitely worse of man, than man deserves.—On this ground I principally take my stand, but without omitting such subsidiary arguments as I think pertinent to my subject.

In order to form a dispassionate judgment of the question, it may be necessary to discover, if we can, the foundation of that universal interest in history, which every age and nation bear testimony to. For, it being an acknowledged fact hat history has obtained this interest with man, it may be presumed,

that this could not be, unless history were eminently useful as a moral instructor. Now I apprehend that this interest in history has no respect to moral at all, but derives itself altogether from that curiosity of the human mind, which impels to the pursuit of knowledge of every kind, and from the passion for the grand, without any regard to the useful or the moral. Both of these motives may be associated with the useful and the moral, and they may and do act as independent principles of human nature. They are two very powerful stimulants of the mind, and do alone account for many striking phenomena of man. To know, and merely to know, is the business of man from the cradle to the grave; it is the province of other principles to apply the knowledge, when acquired, to whatever purpose. Now if history conduced to no other end whatever, than the gratification of this curiosity, man would be impelled to the conversation with history; for, curious to know every thing, he could not be incurious in a subject which so much regards the actings of his own species. The useful and the moral may be the fruit of this knowledge, and they may not, but curiosity would alone enforce the enquiry. To this powerful motive is added the passion for the grand, that most fascinating and irresistible impulse of the

soul. Now as history exhibits man on what we may call a grand scale; for it is appropriately the history of the great, the powerful, the splendid, of man by the combination of many circumstances moving in the face of his fellows, as with the energy and majesty of a God; I am persuaded that to this strong attraction we principally owe that unsated interest and gratification which history administers. We all feel the power of this principle, and know how little it is controuled by consideration either of the useful or the moral. The awful and the terrible attract, because they are grand; and the awful and the terrible are abundantly found in history.

Philosophers and abstract moralists will not allow the character of greatness to any quality of man, separate from probity and virtue. But history knows no such theory, and the common sense of mankind accords with the judgment of history. High sounding titles, splendid decorations, and a power that accumulates the force of millions, will, in despite of the philosophy of Horace, Juvenal, or even the New Testament, bow the free spirit of man, and command a general homage. Even the substance of power, without the dress of power, would sink into familiarity and contempt. Take away the diadem the sceptre,

the retinue of guards, the ermine robe, or even the wig; and the king, the senator, the magistrate and the judge would lose half their dignity, and be almost considered as common men.

But there is a real grandeur in the actions which history records, which demonstrates a superiority of talent, and which even the fastidium of a cloister must acknowledge. Cyrus, Alexander, Themistocles, Militiades, Epaminondas, Hannibal, Alfred, Edward III., the Black Prince, and Henry V. of England, Hunniades among the Poles, Scanderbeg of Epirus, Gustavus Vasa, Gustavus Adolphus and Charles XII. of Sweden, Frederic the Great of Prussia, even the Barbarians Genchischan and Tamerlane, and among statesmen, Pericles, Tully, Richlieu, and the great Lord Chatham, all display this grandeur of talent, which, be the moral character what it will, enforce admiration, and constitute the charm, which interests the reader of their story. Nor will the manly spirit of England, with all its laudable indignation of his insults and his crimes, refuse this tribute to Bonaparte himself.

Here and in the active spirit of curiosity lies the whole secret of that interest, which all feel in history. We seek not for moral; his

tory intends it not; and what moral may be extracted from it, lies too deep for the herd of readers; and the historian, actuated by the same motives and spirit as his reader, obtrudes not the latent moral upon him. It is to gratify the thirst of knowledge, the knowledge of what man has acted on the great theatre of this world of ours, and to gratify the passion for grand display, grandeur of style and grandeur of talent, that the historian writes, and never fails to attract a host of readers; and the developement of this theory will be found very materially to affect the discussion of the question in view.

But I deny not that history subserves to many important uses. These uses it becomes me to notice, and such is my own affection for history, that I wish I could add every praise which its most passionate admirer contends for. These uses chiefly apply to specific characters and stations, but little enter into the contemplation of the many, and can hardly at all be reaped by them. The soldier, the statesman, and the philosopher constitute the three classes to whom history appropriately addresses her lessons, and to them she is of special importance, and must be a source not only of amusement, but of the most valuable instruction. In the detail of military affairs, of the various operations and manœuvres, which enter

into the practice of war, of battles, sieges, marches, counter-marches, blockades, and encampments, the soldier may derive much valuable instruction, and a general insight into the best exercise of his profession. In the history of the negotiations, the treaties and intrigues of governments, the divisions of nations, their connections and dependencies, the political conduct of great and leading ministers, the statesman is to acquire that knowledge and experience, which are essentially necessary to him in the discharge of his public duties. While in contemplating the revolution of human affairs, the rise and decline of nations, with the causes that have contributed thereto, the advancement of some to civilization, science and arts, the relapse of others into barbarism, the progress of general knowledge, the influence of climate, government and laws upon the character of man; the philosopher will be enabled to derive much of wise, useful and moral information.

The field of this application is indeed exceedingly limited as to the number of its subjects; but it may be urged, that the high rank in life of those individuals, to whom history thus addresses her especial instruction, amply compensates for their paucity; and it may farther be urged, that science, of whatever kind,

addresses herself to all, that every human being has an interest in the speculations of the soldier, the statesman, and the philosopher, has a right to appreciate their talents and their services, and therefore to participate in all the sources of their peculiar acquirements. This no one can or ought to controvert, but in order that history shall minister to this high cultivation of the mind, it is necessary that it be the subject of our serious study and reflection. It is not a slight and superficial perusal, it is not the mere knowledge that such a general existed, that he gained such a battle, won such a town, conquered such a province, that will suffice; but we must explore the co-operating causes of his success, whether he owed it to his own judicious skill and improvement of the favourable circumstances which occurred, or it was merely a kind of good fortune; we must trace his progress on the map, and acquaint ourselves as much as possible with the local circumstances of the countries which are the theatre of his warfare; we must enquire into the motives and criticise the wisdom of his various movements, know his discipline, his tactics, and contrast them with those of his enemy; but above all, to estimate his character, we should carefully observe, how he won the affections, possessed himself of the confidence, and

breathed his own heroic soul into that of his army; or, negligent of, and incompetent to both, sunk his troops into feebleness and dastardy. In order to acquire from history a scientific knowledge of politics, we must study the general character, as well as the peculiar manners and customs of the nations and people whom it treats of, the nature of the government and the physical strength of those countries with which the political actors of the times are connected; we must review again and again the varied conduct of eminent statesmen; the policy, the wisdom, the patriotism and the virtue of their schemes; the means by which they carried them into execution; the prudence of their financial arrangements; in fine, the general system and tendency of their domestic and foreign policy; whether like a meteor it be temporary and fleeting, or like the œconomy of nature, permanent and comprehensive. In the moral philosophy of history, it is a more nice and delicate task, amidst a variety of apparent, delusive and often contradictory causes, to elicit those which can alone conduce to the stability, independence and true prosperity of nations, and upon which the advancement of mankind in knowledge, virtue and happiness absolutely depends; to penetrate a thick and turbid mass,

and discover the true theory of human nature; that seemingly latent but indestructible principle of moral, which confounds the deep and well-planned schemes of designing selfish policy, which survives the wreck of contending empires, and the wide-spreading desolation of barbarian conquest, which from the very grave of ignorance, superstition and vice regenerates man. In this way history may certainly be studied to great advantage, and where there is time adequate thereto, and where there are talents prepared and cultivated to this purpose, every human being may derive from history a generous gratification and much solid benefit.

There is another valuable purpose to which history subserves, in teaching to man the magnitude of his powers, and the inexhausted resources on which in every emergency and difficulty, exertion, fortitude and magnanimity have to depend. This is a lesson which man needs, and sufficient to confer on history all the dignity and praise which are ascribed to her. The most vicious as well as the most honourable characters recorded in history exhibit this lesson to man. The fortitude, the perseverance, the unsubdued spirit, with which both ancient and modern heroes keep on their course through the most formidable difficulties, summon to their aid those powers, which trial

and necessity could alone have discovered to them, and by the vigorous and steady application of which they triumph over every resistance, and attain their desired object, unfold a view of man, which could only be learned from the grand and extended display of human talent which history exhibits. This I consider as by far the most valuable use to which history subserves; and certainly applicable as a lesson to a wider range of extent than the former uses which I have noticed.

But to the far greater part of mankind, who, from the destiny of their lot are assigned to different purposes, who either cannot, or think that they cannot, penetrate the mysteries of the soldier or the statesman, or follow the philosophic moralist in his deep and abstract investigations, these concessions do by no means apply. Occupied in the common concerns of the world, they have neither the time, the inclination, nor the abilities which enable them to derive from history these important advantages, nor are they invited and encouraged to the attempt by their more favoured superiors. If they peruse history at all, it is merely as an idle and passing amusement, or to acquire a cursory knowledge of a few leading facts and dates, in order that they may not appear utterly ignorant of former times; a

species of knowledge, which can neither much improve the understanding, better the heart, nor contribute to one valuable end. Perhaps I am not wrong if it be my farther opinion, that to uncultivated and unfeeling readers of this description, history may not only be an unprofitable, but in its consequences an injurious occupation. Some may deem it only a pleasing illusion of the imagination, but I hold it as a truth, that the virtue, which constitutes at once the ornament and felicity of man, has most of the graces in her train, and amongst these, that modesty, which declines a proud shew to the world, is a distinguished and inseparable attendant. It is therefore, that we rarely meet with virtue in the splendid display of history, whether in the court, or in the camp, in the senate, or in the forum, or even in the academic grove, or, where she might at least be suspected, at the tribunals of executive justice. And it is therefore that the vices of man are thought to preponderate over his virtues, because history is little other than a record of his follies, his crimes and his misery. Whether we take a retrospective view of past ages, or consult the present history of the world, what have we generally presented to our view, but one disgusting series of the heaviest calamities and the most shocking

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vices, that can afflict or degrade humanity. We hardly turn over a page, which is not crimsoned with blood, or polluted with foul crimes. Barbarous violence, sanguinary wars, horrid devastations, merciless persecutions, murders, rapes, poisons and assassinations, lordly tyrants trampling upon and insulting the rights of human nature, and abject slaves crouching beneath the yoke of a withering despotism, which from age to age has gone on debasing the human character, and blasting every rising effort of genius and virtue.—Such are the scenes which history chiefly exhibits to our view. To the reader, therefore, who looks perhaps solely for amusement, and with no view to any specific instruction or advantage, such a picture of the debasement and misery of his fellow creatures can afford no gratification. Where the heart is not strangely corrupted, its most natural impression must be that of pain and disgust. Who can peruse the bloody proscriptions of a Roman triumvirate, the devastating march of a Genchischan or a Tamerlane, the barbarities of a Mexican or Peruvian conquest, the systematic cold-blooded cruelties of a Spanish Inquisition, without the most painful emotions of indignation and abhorrence? The frequent contemplation of such scenes, in which human nature is so outraged,

and yet few, if any, better specimens of human characters are exhibited, must have a strong tendency to corrupt the heart of the reader; to chill all the warm affections of his innocent youth, to induce a cold, illiberal and misanthropic spirit, or, as if all resistance to the general current were impotent, to reconcile him to a partnership in the selfishness and depravity of man. For, as the reader becomes more and more conversant with the continued tale of human folly and wickedness, his estimation of his species must be lowered, and his humane and benevolent principles impaired. It requires indeed a strong mind, and standing upon strong principles, such as the world will not teach him, to resist this most malignant of all impressions. Now and then indeed, it must be allowed that some characters arise, such as Alfred.——What! does history pause at the mention of this single name, and in her lengthened catalogue of kings and legislators and boasted heroes, has she no fellow worthy to place beside thee? Then stand alone, thou glory of the British isle, and be thou alone, that verdant spot in the wide waste of an Arabian desert, on which the wearied and disgusted eye, can gaze with delight; and at the mention of thy name may the heart be warmed anew, and re-excited to every virtuous

aspiring. But even thou, with all thy wonderful virtues, polished in the midst of barbarism, learned in the midst of ignorance, religious in the midst of superstition, and on a throne the father and the friend of thy people, art but as the bright meteor, which for a moment illuminates the dark face of night, and is soon obliterated and lost in the returning gloom.

When we farther observe, that the prospect of the vice and misery which has at all times existed, according to the report of history, has led even men of superior discernment and deep reflection into religious doubts and scepticism, assuredly no little danger in this respect is to be apprehended to the light and superficial reader. For, if any thing can make him doubt of the superintending agency of a wise and good Providence, it is certainly the view of those dismal tragedies which are continually taking place on the theatre of the world; wherein the principal actors not only escape with apparent impunity, but reap the reward of their wickedness, wherein suffering innocence and virtue are trampled on and insulted, while triumphant villany loads it with an unpitying and savage rule.

It is true that these conclusions against the moral government of the world, from the seeming triumphs of vice, and which terminate in

from the temper of the soul, more than from the external condition of life, and finds a field of exercise suited to this temper, in the calm enjoyments of domestic, friendly and social intercourse. But to this indubitable truth the historian pays no attention, and therefore affords no assistance to the common reader, whereby he may correct his false estimate of things, and separate the shewy parade of triumphant crime from sincere enjoyment. It must indeed be admitted that in some rare instances a moralizing historian will let you into the secret which the pride of successful wickedness would hide from the world. If scrutinising pictures of that internal wretchedness, which, like the vulture of Rome, thus gnaws at the heart of conscious crime, were oftener exhibited by historians, like to that of Tiberius in his retreat at Caprea, and of Charles the IXth of France, and of that monster Herod, called the Great, in the decline of their health and life, history would be more useful, a retributive justice as the issue of conduct would appear to have more place in the world than the first face of things countenances, the moral principles of the reader would be less endangered, and few, methinks, would barter the peaceful innocence even of a cottage for the titled grandeur

of many of the heroes of history, if therewith must be incurred the penalty of their misery.

It is also another consideration, and which no philosophical essayist ought ever to be ashamed of bringing forward, in any place, or before any audience, that if there be a truth in that theology, which considers this life as the trial of virtue, the next as its reward; the historian suggests no such instruction, nor is it by him that the reader will be guarded against conclusions which are alike reproachful to man and to the maker of man; it is not from the historian that he will imbibe those more extended and sublimer views, which are consolatory to himself, and gloriously vindicate the ways of God to man.

There is this farther disadvantage to be apprehended from the perusal of history, that whereas we meet with certain characters in which good and bad qualities are so intimately blended, that it is difficult to discriminate between them; and though we are sensible that all is not sound, yet what is attractive so insinuates its colour into the whole, and the union of magnanimity and grandeur with all so captivates us, that we come insensibly to interest ourselves in their success; and as their history is more expanded, our admiration is more and more excited; we imbibe their

views, sympathize with them in their difficulties and dangers, triumph with them in their success; and become at length so dazzled with the splendor of their exploits, and the elevation to which they rise, that if we are not absolutely enamoured with their very vices, yet they are in a great measure lost to our view.

"They have no faults, or we no faults can spy,"

we acquire a false notion of heroism unconnected with virtue; and the detestation of crime, perhaps even of the most horrid magnitude, is so lessened by the lustre of successful greatness, as to plead for its excuse, and dispose us to consider it as the necessary and unavoidable consequence of the circumstances in which they are engaged. And it is truly wonderful to observe, how historians of every age have contributed to this delusion by the unjust applauses which they have bestowed upon certain characters and actions. The heroes of their pens have in general been the great destroyers of mankind; those who have ravaged kingdoms, overthrown empires, and thinned the human race. Men have been deified and sainted, not for the goodness, but for the greatness, of their exploits; not for their endeavours to civilize and improve the state of mankind by the introduction of

mild and equitable laws, and the cultivation of the arts of peace; but for an inordinate and selfish spirit of ambition and aggrandisement. The reign of just and peaceful sovereigns, which, like the tranquil seasons of nature, impart health and life and chearfulness to every thing around, has been regarded as but an inferior and secondary object of their attention, valued perhaps most, as it renovates the energies of a nation, and fits it for the ambitious views of a military successor. No! it is the mighty troublers of the earth, the hurricanes of proud war and conquest which deform the fair face of nature, which in their wasteful progress sweep whole nations to the grave, that has been too much the theme of historic applause and admiration. When we behold the title of Great conferred on such men as Alexander, Cæsar, Lewis the XIVth, or even Peter of Muscovy, every moral and humane mind must reprobate the profanation of the attribute, and lament the folly of the world, which can join in the applause of what it ought severely to condemn, and dignify what merits its abhorrence and execration. But the common vulgar of mankind too easily adopt the very prejudices which are their ruin, and caught with the whistling of a name, fall down before and worship the very beast that

is to devour them. Thus, by the false colours in which such characters are exhibited, the moral judgment and the moral taste of many a reader is most deplorably perverted. If romances and novels have erred in raising the notion of human virtue above its level, history has more dangerously erred in the low appreciation of the human character, and associating it with every vice.

From the heroes of antiquity have sprung the race of the wasteful conquerors of nations, the disturbers of the peace of man. Achilles begat Alexander and his turbulent successors; Alexander begat Julius Cæsar, with the long and horrid series of Roman emperors; and the bewitchery of Cæsar's character will never cease to propagate the lust of overbearing dominion, without one end in view, but the mere fame of extended empire and despotic sway. To this we have owed the embryo attempt of Charles V. of Austria, and of Lewis XIV. of France; and at this moment owe, more perhaps than to any other cause, the present troubler of the world. An ample career of solid glory lay before him; but the ghost of Cæsar and the dream of more than Roman empire appear to haunt his sleeping and his waking hours; they have turned him from all honourable course, nor will suffer him

to pause, until, to serve some wise ends of an avenging providence, he be permitted for a while to spread desolation around; or fall at once, himself and his deluded country, a mighty ruin, a just but an inadequate atonement to an offended and harassed world.

Such is the aggregate of immoral impression, to which history, as it has hitherto been conducted, does conduce. I am aware of the high repute which history has obtained in every age and nation, and that I have a general and even a liberal prejudice to resist. History has been considered as among the sublime productions of human genius. As a work of genius I have not arraigned her, I can even with Cicero, allow her to be a Magistra Morum, of manners certainly, and of moral in some degree; and I have so allowed her, but only to a select few; while to the many I contend that she is a dangerous and immoral instructor; in which, perhaps, Cicero would in part have ~~have~~ agreed with me, if he had taken the many into his contemplation. But we should in many respects have differed; our morals, our politics, our religion, would not altogether have harmonized, and Cicero would have highly hated many of those evil tendencies of history to which I have assigned the highest importance. History has powerful attractions,

is to devour them. Thus, by the false colours in which such characters are exhibited, the moral judgment and the moral taste of many a reader is most deplorably perverted. If romances and novels have erred in raising the notion of human virtue above its level, history has more dangerously erred in the low appreciation of the human character, and associating it with every vice.

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least, I have charged to the account of history. While in the page of history we contemplate the degraded state to which vice, ignorance, and the dominion of false and illiberal prejudices have so greatly subjected man, it does indeed, require a strong and well prepared mind to look on this degraded picture of humanity, without having our own principles of integrity and benevolence weakened and perhaps subverted; or our confidence in the superintendence of an over-ruling Providence endangered. All the events of history which are opprobrious to humanity will, by the judicious reader, be referred to their proper cause, to the corruption, not to the depravity of human nature; that easy refuge of men, who are themselves corrupted; nor in the sentence of one, or a thousand villains, will he involve the whole human race; and thus by a rash and unjust inference, rob man at once of his God, and of all generous confidence in the work of God. In fine, the fascinations of splendid crime should not screen the criminal, but the natural abhorrence of wickedness, rising in proportion to the enormity of its examples, should strengthen the virtuous inclination of the reader's heart. To read history with truth and with advantage, the nicest discrimination of causes is often requisite. Folly and error

are frequently as prominent in the page as deliberate bad intention, but by the historian and his reader the deceived are rudely confounded with the deceiver, the seduced with the seducer; while many of the most overwhelming calamities which have fallen on mankind may with great truth, be referred to an honest, though mistaken, principle of virtue. This might be illustrated by many memorable examples, but to adduce these would lead me into too wide a field, and exceed the limits which I apprehend are prescribed to me. I may be allowed however to observe, that inattentive to this just discrimination, history and its readers often pass the most erroneous judgments, condemn where they should pity, enflame where they should instruct, excite national antipathies, where national sympathies would be the wiser and more salutary application, and authorize the most pernicious of all conclusions, the moral depravity of man, where in the intention of the actors the moral character of man is most prominent.

Vice and atheism are certainly unnatural to man. Vice, in man as a part of the general system, is a state of great disorder, offensive as a spectacle, and so far as it extends, operates to the destruction of this part of the system; while in every other part of the ge-

neral system the most regular uninterrupted order and harmony are observed: It is contrary therefore, both to the general order of nature, and to the order of man, which is confessed by the odium which the common sense of mankind annexes to it, and by the aversion with which man contemplates its ruinous effects.—Atheism is yet more unnatural, for every character of nature is to man the proclamation of a God, of a wise and designing author. But independent of the scenery of nature, in the contemplation only of man himself, to deny a God, is to deny himself. For, man is certainly an effect, the commencement of his being is a demonstration of it; but an effect in the very term acknowledges a cause, and an adequate cause, and the denial of the cause of his being is not less absurd, than the denial of his own being itself. We should pronounce the man an ideot or mad, who doubted his own existence, but to be uniform and consistent, this the atheist ought to do. The attribute of ideotism or madness would not be increased thereby.

These observations are not impertinent or irrelevant; they arise out of the view which we have taken, and prelude what is the summary of the charges which I have brought against history, that it is one principal cause of the

increase both of vice and atheism in the world. It does not repel the charge, that history is abhorrent to such intention; this I am as firmly persuaded of as the greatest admirer of history can be, but the more I consider the subject, I am also the more persuaded that the charge is just. If vice in a high degree, and atheism altogether, be unnatural to man, there must be some singular cause of the propagation of both.——I will ask a few plain questions.

Is the exhibition of human character in history a fair representation of human nature? Is it the representation of man at all, considered in the abstract? Is it not the portrait of a single class of men, who, from very obvious causes are the most vicious and depraved of men? Considered as the picture of man, is it not a horrid and disgustful one? And yet, as history appears to treat of man in every age and nation, is it not by many considered to be the picture of human nature? Can this fail to have the most malignant effect, to break down the human mind, and reconcile it to vice, as being in the order and course of human nature? Irritated by these passions, which introduce vice at all, man is corrupted beyond redemption by what he conceives to be general example; for, it is in the manner of ge-

neral ill example that history acts upon the mind of the reader. Those who, from their introduction on the stage presume that they are destined to be the privileged managers of the human drama, read the story of their predecessors; the part which they have acted they receive as the part which themselves are to act; the tempting allurements of wealth and power and grandeur spread their charms before them; the delicate question of right and wrong hardly occurs to them, or with not sufficient power to turn them from their course; theirs it is to command, of the multitude to obey; and hence the constant repetition of the same crimes, a kind of hereditary succession of injustice violence, fraud, broken faith, cruelty, and all the ill-featured progeny of wide-wasting ambition. History is more a change of names, than of action and character, and what in her record is favourable to the general welfare of man, is rarely to be ascribed to the efforts, or even to the concurrence of the great actors; but to the operation of seemingly fortuitous circumstances, to the general impulse of the neglected many, to the re-action against crime itself, when pushed to an extreme beyond human bearance, and what is the most true, though the least acknowledged, to the counteraction of a being behind the curtain, who diverts the counsels

of a wicked policy to an end, which is the most remote from the thoughts and the most remote from the wish of the proud actors. The revival of letters and arts, the deliverance of man from the most abject and oppressive slavery, that of Papal Rome, was not owing to the great men of the day, but to obscure individuals, whom, but for the magnitude of the events, history would not have noticed. But these splendid reverses succeeded to a dark and dismal gloom of more than twelve hundred years; and in spite of all their benign influence, the same fell ambition, which sweeps before it in one general ruin, letters and arts and humanity, still goes on; and the fate of Europe, I may say, of the world, depends at this moment on the resistance of one gallant, enlightened, and comparatively virtuous nation; in one awful struggle it is soon to be decided, whether man shall not be driven back by the wild spirit of conquest to the same debased and horrid state from which he was happily redeemed.

REFLEXIONS

ON

HISTORY

AND ON

Historians, Ancient and Modern.

BY

JOHN HOLLAND.

Read Dec. 30th, 1802.

PERHAPS on examination, it will be found that no kind of writing is more ancient than history. Originally it seems that the records of different nations were drawn up in a sort of verse or measured prose for the sake of being the more interesting, and the better remembered. These historical odes were probably recited or sung at public festivals or on days of rejoicing. The next form which history assumed may be called the dramatic, and was intended to be a faithful transcript of actual conversation. Moses is the oldest known historian, who adopted this kind of writing, in

which he was followed by those who composed the Jewish historical scriptures, and with no small success, by the Evangelists, especially by Luke, the author of the book entitled the Acts of the apostles.

Without doubt it is a mode which captivates the attention and enables the imagination to form a picture of events and persons. But if it were generally used, or by writers of no extraordinary capacity or genius, it might become wearisome to readers imbrued with curiosity and eager for information. Hence, possibly, Herodotus has been called the father of history, because he was one of the first to reduce the tales or traditions, which existed before his time into a narrative form. But since he (it is well known) wrote to amuse and gratify the Greeks, at whose public games his works, dedicated to the nine Muses, were recited, so it became necessary for him to adorn his writings with the beauties of style, and with the charms of eloquence. Then almost every thing depended upon public speaking. Whilst state affairs were never discussed in any other way, the very principles of science were communicated with the greatest effect by the most popular orators. It was not therefore surprising, that the historians both of Greece and Rome displayed their talents for

rhetoric by inventing speeches for favorite or distinguished characters. Though Herodotus perhaps first adopted this mode of writing, yet he does not seem to have carried it to such an extreme as some of his successors. The harangues which he probably composed, are much shorter and less elaborate than those which are found in Thucydides, or in Xenophon. Such a style of composition however, was certainly faulty, and by no means consistent with that love of truth, which ought ever to guide the historian's pen. Still it has been thought that Polybius, in endeavouring to avoid such an error, has committed an opposite one, and written not only in an unadorned, but in a repulsive manner. If Justin be excepted, scarcely any ancient historian may be allowed to have preserved the proper medium between the simplicity of narration, and the artifice of rhetoric, or to have united eloquence and correctness with veracity. This indeed is but the abridgment and the translation of a larger work, which, if it had been his lot to compose, he too might have blended the rhetorician with the narrator.

Among the Roman historians, no one seems more to have offended against the simplicity of narration, to have mixed his own sentiments and prejudices with his works, or to have been

more solicitous for the reputation of being esteemed a maker of eloquent harangues than Sallust. As of his prefaces it has been sarcastically observed, that they appear to have been prefixed by blunder to his two histories, so it is certain, that either would suit the description of any corrupted, degenerate, or venal period. Yet since Sallust lived in the times of which he has written an account, it is candid to suppose, that he has faithfully represented the ideas of the orators whose speeches he has given. But the uniformity of his style incontrovertibly establishes his claim to the composition.

With more simplicity Cæsar, in his Commentaries, has imitated Xenophon, the natural sweetness of whose style, has obtained him the name of the Athenian Bee. Yet, without doubt, the Roman has exhibited traces of the same fault, common to most ancient historians, of making orations for others. Excellent too, as in many respects the writings both of Livy and of Tacitus may justly be deemed, they are deserving of blame on a similar account. The copious magnificence of the one is indeed so complete a contrast to the sententious brevity of the other, that perhaps an historical style equally remote from both extremes, would be superior to either.—As the epitome of

Florus might deserve more praise, if the style had been less ornamented, so the Roman history of Velleius Paterculus would have been more highly esteemed for its judicious accuracy, if the author had not bestowed the most nauseous adulations on the gloomy despot Tiberius, and on his hated tyrannical favorite Sejanus.

But the qualifications of different historians both ancient and modern, have been delineated in so judicious and pleasing a manner by Hayley, in his Poetical Essay on History, that it seems the less necessary to enlarge on this part of the subject. Few modern writers have chosen to imitate the ancients in the invention of harangues for generals and statesmen. Even the elegant and classical Littleton, by adopting such a method, has not been able to impart sufficient interest to his history of England, during the reign of Henry the Second, or to have prevented the perusal of his otherwise useful and excellent work, from becoming a tiresome occupation. Though the taste of modern times concurred with the discovery of printing, and the revival of literature, to require from the historian a less artificial, and a less fictitious mode of writing, yet with no better effect, with no greater advantage has the argumentative been sometimes substituted

for the rhetorical style. The historian, in his study, has endeavoured to conjecture the motives which have influenced at least the leaders of contending and opposite parties, till he has imagined himself intimately acquainted with their reasonings and apologies, and as well able to transmit them to succeeding times, as if he had been a member of their councils, or invested with the divine privilege of knowing the heart. But great events, it is well known, have frequently been occasioned or produced by very inconsiderable causes. Hence, if the politician were acquainted, not only with the domestic transactions, but with the private characters of statesmen, he would probably often find that the most important and extraordinary events frequently originate in secret motives in the narrow selfish passions of obscure individuals, the parasites or dependents of the great, or in trifling incidents unknown to the world.

From these and other considerations, it has been argued, that history in general is entitled to little credit, or at least that only public occurrences can possibly be certainly known or faithfully recorded. The rest, it is supposed, must have been merely the conjecture of the historian. But diligence, caution and accurate research, free from theoretical speculation or

party spirit, will probably in most instances discover the proper causes for the most interesting events recorded in the annals of mankind. If these causes seem trifling it may be rational to conclude, that the Divine Providence ordained the issue by means of inferior and unlikely instruments for the sake of leading his reasonable creatures to acknowledge, that the termination was appointed and accomplished by counsels wiser than human.

To the truth of history in general it may be objected, that of some particular periods, even by writers of credit and reputation, different and contrary accounts have been given. For instance, it was long generally received, that Richard the IIId. of England, was remarkably deformed, and that he gained the throne by a series of murders. But Walpole, in his Historical Doubts, has brought documents before unknown, to show that the usurper's bodily frame was not mishapen, and that his nephew Edward the Vth, actually walked in procession at his uncle's coronation. Though it may not be easy to discover what was the fact, yet it is not reasonable to discredit the whole of history, because dark clouds may rest upon some particular parts. It was manifestly Henry the VIIth's interest to blacken the character of a predecessor, who

certainly reigned too short a time to wash away the stain of any ferocious actions, which ambition and civil wars might have tempted him to commit.

In like manner, Mary Queen of Scots has furnished historians with many subjects of dispute. That she was beautiful and unfortunate cannot be denied, but whether she was privy to the murder of Darnley, her husband, or whether she fomented a popish conspiracy in England, has not yet perhaps, been clearly ascertained. Still the credibility of her remaining history cannot reasonably be impeached, whilst it would be flagrantly absurd hence to infer, that no degree of credit is due to the usually received accounts of mankind. There may be many doubts and difficulties in the annals and records of nations, yet either human testimony is not to be believed or the general and leading circumstances are of an unquestionable nature.

When the celebrated Raleigh, during his imprisonment in the Tower of London, was writing the History of the World, a loud altercation under his window interrupted his studies and disturbed his reflections. Unable to hear distinctly the nature or progress of the dispute, he endeavoured to satisfy his curiosity, by asking different individuals who soon after-

wards entered his room, what was the cause of the noise, and what were the particulars of the quarrel. But no two persons agreed in the same account. "Cannot I then, (thought "the sage) learn the truth of an incident in "my own time, from persons present at the "transaction, and shall I presume to write the "history of mankind in remote ages and coun-"tries? Perhaps the best authorities for the "credibility of ancient history, may frequently "be persons, who have received their accounts "from others, as inaccurate or prejudiced as "those from whom I have inquired." Raleigh's work was however written, and is yet extant. The objection therefore, to the credibility of history, which the fray suggested, had but a temporary, or at least not an effectual influence on his mind. Perhaps he had not inquired enough; perhaps he had inquired too soon before the passions of the different parties were cooled. Other spectators or auditors might be less interested or more impartial. The general outlines of the story might be correctly drawn, though in some inferior particulars the narrators might be found to differ.

Histories written by contemporaries, are without doubt desirable productions, but due allowance must be made for the prejudices of the characters and times. Without such his-

tories, it may be impossible for future writers to relate the annals of their progenitors. But as in surveying a landscape, the eye may be too near as well as too distant to discover all its beauties; so perhaps, though the proper materials for history cannot be too soon collected, yet frequently some little time should elapse before they are ranged in order. Contemporaries are apt to dwell upon minutiæ, which render their accounts tedious, which may scarcely be interesting at the time, which every day grow less important, and which are not worthy to be remembered, unless they elucidate subsequent momentous occurrences. Certainly the history of interesting and important revolutions should not be published till the passions and prejudices excited by the contest are worn away, and reason is empowered to pass an impartial decision on the various merits of the cause. As historians assume the office of instructing posterity, so they should particularly beware of being influenced by party spirit.

If in his history of the Peloponnesian war, Thucydides has not excited for his countrymen the Athenians, a greater degree of interest than their ill directed ambition may seem to deserve, yet it is generally acknowledged that Tacitus and Suetonius, who were nearly contemporaries

with most of the events recorded in their respective works, have, with a propensity common to many serious minds, delineated incidents with too sombre a pencil. Had they been at a greater distance from the gloomy views, which they have given, they might have blended a little more light with the shade, and rendered their historical landscapes, more agreeable as well as more faithful and exact.

But if historians who record the events of their own times, be influenced by party spirit, to give various and contrary accounts; their very prejudices tend to cure their own evils, and guide the candid and impartial to the attainment of truth. When a narrator has any inferior object in view, the judicious and discerning are not long in discovering his aim. It was soon perceived, for instance, that Hume was too partial to the Stuarts; and that one of his objects in writing the previous history of England, was to show that the encroachments of the royal power were not without precedent in the reigns of the Tudors. Though the question might still be referred to principles of general policy and justice, yet if the mind should receive an undue bias from such representations it may easily recover its bent, by application to the narrative of Macauley, or if that be thought too favorable to the republican

party, every prejudice may be removed by perusing the pages of the patient and candid Rapin. It has been sarcastically observed by Voltaire, that the best history of England was written by a foreigner; but it should be recollected that this foreigner was a student of the English law, and previously well acquainted with the principles of civil and religious liberty. Whether Henry's history of Great Britain may not wrest the laurel from Rapin, future ages will probably determine. Perhaps the principal defect in this excellent work may be too rigid an adherence to a previously formed plan, which separates subjects naturally united, unnecessarily multiplies references, or occasions frequent and tedious repetitions.

Probably it will be found after diligent and careful examination, that history best divides itself, or that a correct retrospect of human annals will suggest a just and proper distribution of them. Mosheim has, perhaps, injudiciously divided his ecclesiastical history into centuries, and has thus rendered a subject in itself not very fascinating, still less alluring. Historians who mean to recommend the themes which they have chosen, will find it their interest to contract or dilate them as they are less or more interesting or important, without any respect to the periods of time, which they originally

occupied. Ancient events may be considered by the understanding, as distant objects are beheld by the eye, in a general though connected manner. Hence, perhaps, Chesterfield in his letters to his son, yet probably not without a view to his future diplomatic or political employment, has recommended modern history as an object worthy of particular attention.

Possibly from a like motive, some modern writers may have selected remarkable periods for the themes of their narration. Though they may not have given them the proper titles, yet it does not follow that the transactions of such times are not deserving of more regard than those of others.

Certainly the æra, when the younger Anacharsis is supposed to have lived, was a most interesting period in the annals of the Greeks. As among them philosophy never attained a higher elevation, so from that time along with the spirit of liberty and public virtue, it began to decline. Whilst in this excellent work of Barthelemy, probably no more is fictitious than the name and character of the supposed writer, the whole conveys a more complete idea of Grecian history and philosophy, than is perhaps any where else to be found.

In like manner Middleton's life of Cicero, embracing the most enlightened and interesting

period in the Roman history, claims a diligent and an attentive perusal from every friend of liberty, oratory and science. Voltaire's Age of Louis the Fourteenth, should not be condemned merely for its title, nor censured till a better can be found. As it was certainly a period, which displayed ambitious tyranny, but was distinguished for polite literature; so the writer, notwithstanding his prejudices for the supposed grandeur of his country, has not failed to delineate the subject in both points of view. But without any prejudices of such a nature, Robertson has chosen for one of his themes the reign of Charles the Fifth, a period remarkable for the secession of the Protestants from their obedience to the see of Rome, and noted as the time when the system called the balance of power, was established in Europe. The reign of Philip the Second was an æra of bloody persecution, and has, in very plain and unaffected language, received its just condemnation, in the history of Watson.

In like manner the lives of Poggio Bracciolini, and Lorenzo de Medici, are at least interesting to classical scholars, because they describe the period when by their labours and researches, the most celebtated works of the ancient Greeks and Romans, were not only redeemed from the obscurity of the dark ages,

but collected and preserved for the instruction and improvement of posterity.

Consistent and regular students of history will not, however, content themselves with reading the annals of mankind in detached portions. But whilst they pay a proper tribute of respect to the works of those writers, who have selected striking periods for the labours of their pens, they will endeavour to collect a just and complete idea of all the events, changes and improvements, which have taken place in the world, from the earliest ages of which there is any account, down to the present day. That war should engross so much of the historian's attention, may justly be lamented by the benevolent and humane. Yet whilst the faithful description of its incidents may render it still more an object of horror, it cannot be denied that contrary to expectation, and in opposition to the efforts and opinions of the ambitious and tyrannical, it has, in various ways, contributed to the progress of liberty and knowledge. In this sense "discord is harmony not understood, and partial evil universal good."

What is the best method of studying history it may not be easy to decide. The ingenious D'Alembert has argued, that the most natural mode, at least for young persons, was first to read

accounts of their own times, and then to peruse the annals of former periods immediately connected with them in a kind of retrograde order, till curiosity carries them up to the most ancient authentic records of mankind. The method may be agreeable and enticing, but so far from superseding the usual chronological course of historical study, it may still require for the sake of producing its complete effect, that events should be regularly contemplated from the earliest periods, and considered as they have happened in the order of time. The mechanic who would be master of his art, should not only understand the several parts of a machine, but should be able to put them together. The annals of mankind contain the history of civilization, and, in fact, present it to the mind as a work of Divine Providence. Whoever therefore, would have just notions of its progress and improvement, whoever would trace it to its proper author, should contemplate its origin and observe its melioration through every succeeding age.

In many points of view therefore, history, faithful history, is worthy of study and attention. It was perhaps the oldest poetry, and has certainly not only suggested to poets of different ages and nations, particularly to Virgil and Thompson, some of their most

pleasing allusions, but in some instances, especially in the epic and dramatic provinces, it has formed the very basis and argument of the most popular works. Long before dramas were performed, and, as it were, by way of pattern to them, history existed in a dramatic form. The recitation of noble actions to free-born minds hath, especially in Grecian times, inspired them with a love of liberty, and influenced them to serve their country and mankind. If the Roman history, together with the life of the Macedonian Alexander, contribute to encourage the spirit of lawless ambition, the decline and fall of that renowned empire may also concur with the fate of all warlike heroes, who have transgressed the rules of justice, to warn the mind against the evil and destructive consequences of an insatiable thirst for glory and power. Numerous examples of sublime, pathetic and impassioned eloquence, may be derived from the works of ancient historians. Their modern brethren have rather contributed to the spread of policy, philosophy, and commerce. If the narrations of historians who were cotemporary with the events be more worthy of credit than others, the advocates of revelation may with confidence appeal to the historical scriptures, and point out Moses and the Evangelists, especially Luke, as in an

extraordinary manner with the simplicity and faithfulness of honest and holy men, exemplifying the truth of this assertion. Since the histories of memorable periods, probably supply lessons of wisdom in the greatest abundance, whilst they are on that account more deserving of study, the works of those illustrious men, who have chosen and graced such interesting, important and useful subjects, will be read with peculiar pleasure and improvement. If the mind sicken at the idea that history principally details the crimes of mankind, it should reflect that these may, for that very reason, be only the more extraordinary and uncommon. At least it should not omit for relief to take a view of those improvements in the arts and sciences, which manifest the ingenuity of man, and demonstrate the providence of God. If there be a sincere love of goodness in the heart, the attention will finally rest upon those instances of public and private virtue, which impartial historians cannot fail to delineate. Though many of these were not contained in the pages of biography, which may, perhaps, by way of eminence, be called the school of moral wisdom, and which is no where better exemplified than in the writings of Plutarch, a very judicious as well as copious selection of them may be found in the second

and third of Priestley's Historical Lectures.—If, therefore, a work unite the advantages both of public and of private history; if it display not only the crimes but the virtues of mankind; if it delineate the progress of civilization, the advancement of the arts and sciences; if, by its examples or warnings, it tend to inspire the mind with the love of goodness, and with an abhorrence of vice; if it confirm the truth or shew the excellence of natural or of revealed religion, it may effect some of the most important purposes in human life, and render men wise and benevolent, holy and blessed for evermore. Since, then, history may teach both wisdom and virtue, and since it undoubtedly displays what progress men have made in improvement of various kinds, it may justly be termed the volume of providence, and may join with nature and divine revelation; in proving that all things work together for good.

On NATURAL and MORAL PHILOSOPHY,

AND THE

Proper Manner of Philosophising in both.

BY

The Rev. G. WALKER, F. R. S.

Read March 5th, 1802.

IN the works of a powerful, wise and designing artist, whoever this artist be, we expect a similarity of general plan; that there be in each an end, and a respectable end in view; that the means be adapted to the end; that there be neither superfluity nor defect of means; that the means be simple, but extensive in their operation; and that the manner of executing one work, and producing the end contemplated therein, do not deviate from the manner in another, more than the nature of the subject requires.

Thus, if the universe, of which ourselves are a part, be referred to a powerful, wise and designing author; and if it be not, it is, though

the most astonishing of all productions, the only one which we admit to exist without an adequate cause, it will be expected that a similarity of plan, and of means adapted to the end, will be exemplified in the provisionary furniture of every part of the natural and moral creation.—In the material universe, though infinite forms exist, and constitute an infinity of species, yet every species has an appropriate character, has a specific end to subserve, and by some latent constitution, of which we can give no other account, than that it is the will and gift of its author, is furnished with powers, which enable it uniformly and invariably to sustain its part in the creation.—We acknowledge this appropriate character in every species of the fossil, the mineral, and the vegetable kingdoms. Animal life with its faculties and functions presents so different a scene, that we know not how to consider the beings of this order as mere varieties of material form; yet in the individuals of any species of the animal kingdom, except man, we observe an almost perfect uniformity of character to a similar cause as in a fossil or vegetable species, viz. to a latent constitution, originating with their birth, unfolded in their progress, from which every impulse and movement issues, and short of which or beyond which they cannot go.

To be more particular, the different classes of earths, stones and metals, have each their peculiar properties and specific differences; and if it be asked, whence they derive these properties, and what has impressed upon them these specific differences, no answer can be given by the Theist, but that the hand of the Universal Creator has for wise purposes so formed and furnished them, nor by the Atheist, but that so they are. They both admit a primary and elementary character in each species as a datum. If from combinations of the simple forms, new kinds be produced, the character of these compounds is supposed to be derived from the characters of the component parts. The classes of the vegetable kingdom appear to be much more numerous, and probably from this circumstance such a resemblance is observed in the approximate kinds, as misleads the vulgar eye, and exhibits them as one and the same. But to a careful observer they are essentially distinguished, and each kind propagates its kind, and with the same properties, though from adventitious causes they may differ in the degree of these properties. The progeny of every kind has unalterably the specific character of its parent, nor ever, under the operation of nature or man, appears under the specific character of another kind, however approximate

the kinds may be. Although from the seeds of an apple or a gooseberry a thousand subordinate species of apples or gooseberries may be produced, yet they are each separately apples or gooseberries. From the seed of the apple never springs a gooseberry, a pear, a cherry, or any other vegetable whatever, and *vice versâ*. We have no reason to suppose, that from the period of the creation, any such transmutation has taken place, or one new simple form been produced, though it is possible that some may have been lost. Compound kinds from kindred and proximate species may, perhaps, have issued; but such as are the essential properties of the kinds which enter into the union, such probably will be found to be the mixed property of the compound. I speak here with diffidence; for I do not know that a new and mixed kind of vegetables has ever been produced from two primary kinds; or, if such a phenomenon have taken place, that such a vegetable mule has been able to propagate its kind, and introduce a new species into the vegetable kingdom. The different classes of the material creation do most probably continue unalterably the same as they were at first formed by the hand of their author, each at least with the same specific differences and properties, though in the degree and proportion

of these properties difference may arise from adventitious causes. Situation, climate, culture, must effect a difference of magnitude, splendour and taste.

It is impossible to resist the same conclusion with respect to every species of animals, except man. Here alone the question lies. Every individual of each animal species discovers a common character, common properties, performs common functions, tends to a common end. The qualities characteristic of one are possessed by all; each has its range of action circumscribed within the same limits; there is a common end and purpose to which each is fitted. Each attains the summit of perfection in its kind in a very short period, and to whatever length their existence be extended, they manifest no new powers, discover no new propensities, learn no new lessons proper to another kind; though the tutelage of man, and repeated practice under this tutelage, may render them more facile, and enable them to exhibit a certain novelty, in some of the movements, which constitute their general character. The progeny of each is of the character of the parent, and though from commixture a spurious breed may be produced, yet no properties are exhibited but what are found in the parents, while the incapacity of the mule to propagate

prevents all derangement in the order and classification of the animal tribes. To animal life are attached consciousness, taste, volition, and to some of the higher orders a portion of the finer qualities of man are given. In consequence of this destination of certain animal species, and this capacity for higher attainments, a greater diversity of character is observed in the individuals of such species, than in any vegetable class. In some degree they are susceptible of education; in some degree acquire tastes and habits, and perform manœuvres, which in the ordinary state of their nature would not be expected from them; consort with animals of a different order; imitate their peculiarities; associate even with man; look up to him with reverence, gratitude and affection; are observant of his will, and entertain the strongest personal attachment to him. But these observations of individual character, if they may be so deemed, are not numerous, are found only in a few classes, are carried but to a small extent, and still the common character of the kind is greatly predominant.

Here, therefore, in the whole of this earth of ours that is subject to our view and examination, except man, we find a similarity of plan, an end and a respectable end to be contemplated by the artist; we discover a furniture

of means adapted to the end, no superfluity or deficiency of means; that the means are in each species as simple as the dignity of the species in the scale of creation admits of; that the means, though simple, are extensive in their operation, and, which deserves particular attention, that the end is attained in all the infinite orders of being, in a manner conformed to one general rule, viz. by furnishing the individuals of each species *ab initio* with a constitution, which produces either a perfect sameness, or such a conformity, as discriminates the species. Whether this conformity be denominated a law of nature or a law of God, is of no moment to my present argument. It is sufficient to my purpose that this law, as the proximate cause, is acknowledged by every philosopher, of whatever complexion his religious creed may be, as the only obvious account of that uniformity which characterises the individuals of every separate species.

In aid of the conclusion which I have in view, I might adduce the uniformity of the law, which regulates the motions of the bodies in our solar system, and by a well-founded analogical presumption, of the infinite systems which through the immeasurable extent of space claim each a star as their sun. The law is

one and the same to all, they each move in elliptic orbits, and two properties, viz. that the elliptic areas commencing from the perihelion or aphelion of each are constantly in proportion to the times elapsed, and that the cubes of the distances of the planets from the sun are as the squares of their periodical revolutions in their orbits, harmonise the motions of them all, and assign to each of them, and to their inhabitants their respective order and proportion of days and nights and seasons. No account can be given of this uniformity and harmony, but in one of these two ways, first, that some powerful agent is continually acting upon each orb, so as to give to each that direction and velocity which his will determines. This is not supposed by any one, not even by those, who acknowledge this agent as the primary cause. The second, therefore, as of necessity presents itself, that each planet has impressed upon it a common property or properties, which may be considered as their common constitution, from which are constantly derived the uniformity and harmony of their motions.

We have then advanced a considerable step farther, we have taken into our view, and submitted to our examination, inasmuch as they can be subjected thereto, the innumerable worlds that float in the vast expanse. Though

the furniture and inhabitants of these worlds are unknown to us, and of them we can form no judgment, yet inasmuch as regards the orbs themselves, as productions of the same creating power, whatever this power be, we have found reason to infer the same conclusion, as in the various species which constitute the furniture of our globe. The planets of each solar system are subject to one and the same law, they subserve to one and the same end; the means to this end are simple, but extensive and grand in their operation; they have, in fine, common properties, one and the same nature, and if we may use the term, one and the same constitution.

Here, then, in the vast survey of the whole universe, so far as it can be submitted to our observation and judgment, but still excepting man, we find a similarity of plan, in providing every single species of being with inherent tendencies or qualities, adapted to the part which they are intended to sustain, to the purpose which they are intended to subserve. Our observation of the phenomena and history of each disposes us to arrange them under genera and species, accordingly as individuals discover common properties, and a constant tendency to a common end. Whatever properties in each are not secondary, and can-

not be derived from a higher property, we consider as primary, essential; as constituting the generic or specific difference; and unable to carry our enquiry any farther, we consider these essential properties as the originating source of the common character, as entering into the very nature and constitution of every individual of the genus or species.

Man alone remains unnoticed in this survey, and the question forcibly obtrudes itself, is it conceivable that he alone shall be excepted in this general provision and plan? Has he alone not an inherent constitution, of mind as well as body, adapted to and preparative of his specific character? Are not the elements of this character, whatever it shall be, interwoven and coexistent with his very being? Is a general plan of creation so extensive, so invariably pursued in every other being; than which, simple as it is, none more worthy of designing wisdom and goodness can be conceived; and from which all that strikes us, as harmonious, beautiful and grand in nature as a whole, appears to be derived; is this simplicity of plan abandoned in man alone; who, however dignified in the scale of being he may be esteemed to be, is but a production of the same all-creating artist, issues from the same designing mind,

and is one distinct species of the great animal Genus?

The answer to this question is decisive, so far as respects the bodily character of man. The faculties of sight, of hearing, smelling, feeling, and whatever faculty the human body may discover, are undoubtedly coeval with the birth, or rather with the existence of the individual man, though it requires exposure to the objects adapted to them, before they can be brought into act, and though they may increase in strength and power as the body increases, and in facility of exercise by use and habit. No human being acquires one new sense, one bodily faculty, which is strange and foreign to his kind, however in degree or application to different objects he may differ from his fellow. In all the furniture of the body therefore, there is a sameness of character in man, and this furniture is inherent in the very constitution of the human frame; it is, as in every species of created beings, that elementary provision, which assigns to man his bodily character, and limits its extent.

Whatever the thing in him, called mind, be, it is *sui generis*; but whatever it be, it has properties, which constitute its specific difference, and these properties, having no assi-

milation to the properties of matter, cannot be derived from any property which is included in the view that we have contemplated in matter. They are, therefore, derived from the same source to which we refer every property of every order of beings, or they are an existence without a cause. Man therefore is, and must be, in his mind, fashioned and fitted to all its future character by a nature, a constitution, which is coeval with his existence. This nature, this innate constitution, as in the planets of the solar system, as in every distinct order of earths, fossils, minerals, vegetables, animals, is the provisionary furniture, derived from the one cause of all, fitting it to be what it is, or shall be, when unfolded and expanded in act, in its progressive conversation with the rich scenery exposed to its view and action.

Intellect is one grand character of mind, it appears in the faculty of comparison; in distinguishing genera and species by a community of property, and thus arranging the infinite varieties of nature; in reasoning from effect to cause, and from cause to effect; in the discovery of abstract truths from the relation of equality, proportion or similitude; in logical deductions; in acquiring the knowledge of means by experience, and thus, whatever end be in view, selecting those means which are

most proper to the attainment of the end, and furnishing a constant field of wise, salutary or beneficent activity to man. This is, perhaps, a compleat summary of the whole province of reason, in which, the discovery and the application of means to an end constitute its most important office, every other attribute of intellect being only preparatory thereto. Intellect, however, suggests no end; she is but the servant, the minister to those other qualities of the mind, which interest it in the beautiful, the sublime, the useful and the moral. But whatever judgment be formed of intellect, the capacity, the elements, the principle, from which all its functions emanate, must be born with the man, must be a part of his primary constitution. That he has this capacity, this principle, is a fact not to be disputed; that in this provisionary furniture he is of all the beings within his ken either absolutely singular, or comparatively so, every other display when contrasted with his passing into evanescence, is also a fact beyond all contradiction. And if not born with him, if not provided for him by that being from whom the provisionary furniture of every thing else has appeared to issue, who will presume to ascertain the period at which the capacity is received by him, and affirm that he is sensible of its communication? But

the conclusion would be the same, it is sufficient that it is a provisionary gift, that the capacity of intellect is not his own creation. If he had such a power, the very will to possess it would be argument of a pre-existent intellect. Man, therefore, in one great character of mind, is conformed to the plan which in so large a survey of nature we have found to be uniformly observed. Designed to be a rational being, and act with a deliberate purpose to an end, he has a provisionary constitution of mind fitting him for this dignified walk.

But whence is derived to him the worth and importance of the various ends and enjoyments, to the attainment of which intellect is so valuable a minister? One of these ends is the gratification of appetite, the delight in food. This is not simple as in other animals; appetite in him comprehends a diversity of tastes, multifarious almost as the supply of the vegetable and animal kingdoms. This character, though not to the same extent in all, and subject to the controul of higher considerations, to which in their order we shall advert, is general in man. It is difficult to ascertain the precise limits which separate the different classes of animal being, to say where one specific character absolutely begins, and where it ends, and therefore in a few animals an ap-

petite for a variety of food, beyond what they discover in their untutored state, may be excited by the management of man. But this is so rare, so very limited in extent, that he must be sceptic indeed, who will not allow to man a very striking and characteristic difference in this attribute of his nature, designing him even in this lowest walk of gratification, and lowest end of his being, for a wider range of action, and a wider range of enjoyment, as an incitement to the exertion of his active powers.

But it is remarkable in man, in all this gratification of appetite, extensive and varied as it is, and great as is the portion of time, attention and exertion which is directed thereto, that he feels no sense of dignity as attached to the pursuit; the enjoyment is fugitive; often leaves a palling and disgust behind it; and is one of those pleasures which cannot be reviewed with delight, nor be re-enjoyed by reflection, unless by a few, who are considered as among the debased of our species. Fugitive however as the enjoyment is, it has answered to all the end of multiplying the sum of human gratification; and to all, though in various degrees, and often without being directly perceived, this higher purpose; of inviting to exercise, to health; of provoking intellect, design and plan; of associating with all the nobler qua-

lities of our nature, with the love of order, of the elegant, the beautiful; and what is of still superior import, the rational and friendly intercourse of fellow man. It is the association with these nobler propensities which corrects, limits, chastises the grossness of appetite; separates it from indecency and excess, and gives to it a dignity, a grace, and even a worth, which of itself it would be incapable of.

If, then, analogy be in any instance a safe guide to man, here we without fear may commit ourselves to its instruction. From the extensive view that we have taken of the provident wisdom of the Creator, it is indeed an irresistible conclusion, that mind is not in one instance neglected by him, and therefore, least of all, in a moral view, the sublimest purpose, which man as a creature of the all-forming artist is designed to answer. It must be, that in this, as in every other part of the character for which he is destined, he should have a provisionary, an elementary constitution, not derived from any secondary, but immediately from the primary cause of all; and that his future character, all the phenomena of his succeeding history should be only the developement of this elementary constitution. There are many other circumstances, which may come in aid of this elementary constitution, and co-

operate to the ultimate purpose for which mind and moral mind are in any degree at first conferred; and therefore are also, which may counteract, pervert, and almost destroy this purpose. But of these I take no notice; first, because there is nothing singular in this, since in every direction of man and of his mind, there are both favourable and unfavourable attendant circumstances; and secondly, because a complete system of mind and moral is very far from being my object. I wish only to establish a first leading principle, as the foundation of all subsequent enquiry in moral, as a safe guide to every one, who would modestly and soberly philosophise on man; and, if this principle be founded in the truth of nature, enable him to detect the falsity of other theories, which are derived from other principles.*

I receive it therefore as a *concessum* that mind in man has an elementary moral con-

* It is a question not impertinent to the object of this essay, "Whence originate these finer and more elegant tastes of man, this delight in the orderly, the beautiful, the splendid and the sublime? Whence, indeed, but from the designing hand of his Creator, who intending for him the moral as the highest perfection of mind, prepares him to feel and to enjoy the still more beautiful and sublime of moral by a delicate gradation of tastes, which to him alone of all the animals that inhabit this globe are appropriate, which themselves have nothing of the animal character,

stitution, provisionary for its future display, and that there is a perfect similarity of plan in the adaptation of every being and order of beings in the universe for answering the purpose contemplated by its author. I have, indeed, so far as regards moral, produced no other argument in favour of this conclusion beside analogy; but then it is analogy so singular, that if the statement on which the analogical inference depends be admitted as a fact, and any one shall deny the conclusion, we may venture to assert, that it is not his mind, but his voice that pronounces the rejecting NO. There are other corroborating arguments which lead to the same conclusion, but on account of the extent to which they would carry the subject, more proper to be introduced into a regular composition, which contemplates the whole, than into an essay, which contemplates only a part. If I were even disposed to extend my view, the limits of time assigned to the papers read before this Society do not admit of it.

It is this principle, common to every order of created beings, which constitutes the connection that I meant to insist upon, because,

yet in him can associate with every animal indulgence, and thence derive to the very nature which he has in common with the lower orders of being that chastened grace and dignity which we have noticed.

if true, it connects *ab origine* the theories of body and mind, it suggests a common mode of investigating the theories of both, and by one and the same process establishes a sound and true philosophy in both. It will not be necessary therefore, to dwell long on the object presented in the title of this essay. The connection, which in this title I had in view, is a direct inference from the conclusion that I have endeavoured to establish. If the economy of the natural and moral world be in the designing mind of the Creator conducted in one common mode, there can be but one mode to man of entering into the views of the Creator, of investigating the nature, the characteristic difference, the end, the fitness of every being whom he has subjected to the view of man. The rational world is at length convinced that in natural philosophy no true theory is to be derived from bold conjecture. To arrive at truth, man must reason upwards, and not downwards. He must begin with what he does know, in order to discover what *à priori* it is not possible that he should know; he must retrace the steps of the great artificer, by following him in his works. He must store up facts; compare, digest them; separate those which are consequent from those which are antecedent, and thus in a regular gradation arrive

at the knowledge of those qualities in every order of beings, which have no antecedent, which terminate his enquiry, which he must admit as the elements, the inherent nature of every order. These being admitted as data, he may then safely reason downwards, and from thence as a sufficient cause, satisfactorily account for every phenomenon, and seise to his use, and apply to the most substantial and gratifying purposes, the solid knowledge which he has acquired.

In this manner has Natural Philosophy been successfully prosecuted for a long period of years, and the secrets of nature been explored with honour and with advantage. The fossilist, the botanist, the agriculturist, the horticulturist, the anatomist, the physician, the philosopher, in a large sense, who comprehends all these departments; and last, though not least, the chemist, have learnt to tread in this path, and have contributed to rescue philosophy from the disgrace of arbitrary and misshapen theories. The philosophy of mind and moral invites man to the discovery of their more important and sacred truths only in the same road. As the principle which has at length prevailed on man to quit the road of conjecture in natural philosophy, in quitting which, if at all, natural philosophy can alone

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be perfected; as this principle, viz. an elementary constitution in every being, is common to mind and the subject of moral, there is, there can be, no other means of arriving at the truth of nature in this interesting subject, but by the same analytic process as in all the departments of natural philosophy. We must admit that there is an elementary principle of moral in the mind of man, and to discover the character of this principle, we must attempt what I have observed to be so successfully accomplished in the philosophy of matter. We must collect all the phenomena of the human mind, the great facts, which constitute the history of man; we must compare, digest these facts; arrange them in classes; separate those which are consequent from those which are primary, which have no antecedent; and thus ascend to those qualities which constitute the elementary nature of mind, which reveal the will of its author, and which, if in this analysis any rule can be discovered for assigning to each primary quality its respective place of worth and dignity, will, in every application, fix the standard, and pronounce the judgment of moral.

It may be thought by some, that the whole of this essay is unnecessary, because they have never entertained the idea of philosophising in

the subject of mind and moral in any other mode than what is here recommended. But to me nothing appears more unsettled than the subject of moral, nothing less deserving of the name of philosophy than the crude and contradictory theories of mind and moral, which divide the plaudits of the modern world. If the same mode of reasoning as in the study of natural philosophy be the only road to truth and useful truth in the science of mind and moral, these theories and the favour with which they are received, abundantly prove that this road is not yet much walked in.

I shall conclude this essay with a few queries, which may suffice to shew, that some favourite theories and doctrines respecting mind and moral will not abide the experimental test.

I might summon many writers to this examen, some who have composed professed theories, others who have only in a desultory manner discussed the subject of moral, though to such discussions their fame has been not a little indebted. This, however, would carry me too far. Indulgence to a few queries on the two favourite theories of the *useful* and the *selfish* is all, if not more, than it becomes me to expect.

Do those, who make utility the foundation and origin of morals, derive their system from

intentions, man often entertains very erroneous conceptions of utility. It is, indeed, a most fortunate truth, that our judgment of the moral is much more correct than our judgment of the useful.

It is another question, that if by utility as the origin of all moral judgment be understood a regard to the greatest public good; what is it that carries the individual out of himself, and makes the interest of others desirable to him? This very desire is the surrender of the whole theory, it is the acknowledgment of the benevolent principles as the origin of benevolence, the most dignified of all the moral virtues. If it be answered, that public utility is regarded only as it involves the interest of self, and is the best security for it, the theory of general utility as the origin of moral judgment resolves itself into the selfish scheme, and must stand or fall with it. To this therefore I advert in few words, and ask the defenders of the Selfish System,——

Is it a prominent fact in human nature, that the moral judgment is measured by the interest of the judging mind? Is it a fact, that the eye of the mind is turned upon self, upon its own convenience, utility, and advantage, before it dare to pronounce the sentence of right and wrong, of approbation and disapprobation?

Are no moral verdicts recorded, where the subject on which the sentence passes, can hardly by any ingenuity be brought home to self; or if it can, where the advantage to self is so remote and involved in so many chances, that it can hardly be deemed to weigh a feather in the scale? Or, if even this evanescent advantage be allowed to influence, are not these moral judgments pronounced, where the very idea of a selfish interest is not present to the thought, and there being a non-entity to the mind, cannot possibly contribute any thing whatever to its judgment? Is not the sacrifice of self often, and in the most important instances, the immediate consequence of the moral sentence, but yet in despite of the strong remonstrances of self, something in the constitution of the mind demands the sentence, and it startles with a kind of horror at the thought of a contrary decision? I would ask also, whether the sacrifice of self be not essential to the acknowledgment of a praise-worthy deed, whether the rate at which the deed is estimated be not in proportion to the magnitude of the sacrifice; and whether the praise be not universally withdrawn, if an act of the highest moral form be discovered to have sprung from a selfish motive? Is not the hero in morals always represented, and always the more ad-

mired, in the conflict with difficulties and dangers, in the exposure of self to every thing which is alarming and awful to self, in the sacrifice even of life, and all through the imperious influence of an image of the mind, which is for ever alluring, beautiful, sublime?

I give no answer to these queries, I submit them, gentlemen, to your consideration, as suggesting a more than probable error, which enters into the fabrication of such theories, and the necessity of recalling enquiry to the only way, whereby, if possible, error may be avoided in explaining and ascertaining the true theory of moral mind.

A REPLY

TO

MR. DALTON'S OBJECTIONS

TO A LATE

Theory of Mixed Gases.

IN A LETTER FROM THE AUTHOR TO DR. HOLME.

BY

MR. JOHN GOUGH.

Read Jan. 27, 1804.

SIR,

A LETTER from my friend Mr. Dalton informs me, that my theory of Mixed Gases has been lately read before your Society, where the leading opinions of the system were controverted by my friend, who may be justly called the present champion of the contrary doctrine. Opposition on his part was reasonable, and might be expected; because the human mind is naturally partial to its own conceptions, and frequently condescends to practise a little self-delusion, when obliged by the force of facts and arguments to abandon a favourite notion. No man is exempt from the impositions of self-love; and the universality of the passion forbids us to construe a particular

error of the kind into a personal failing.—— Reasons were offered in my former essay on the present subject, to shew the impossibility of two gases intermixing, so as to comply with the demands of Mr. Dalton's hypothesis; and his method of avoiding the consequences of the demonstration appears to be a device, suggested by the crafty manager of the heart and its affections; for I entertain too high a sense of his mathematical knowledge, to assign any other cause for so manifest a departure from the principles of the mechanical philosophy. The following passage, relating to the matter in debate, is copied from his letter. "In the "place, where a quantity of the gas A is sup- "posed to be thrown into the compound C, "you infer, that upon my hypothesis, the "lighter must ascend and remain at the top; "I infer, that they will instantly be in a state "of commotion, until they become uniformly "diffused through each other; and that the "consideration of the centre of gravity of the "fluids never comes into the question; be- "cause the force of gravity upon any one par- "ticle is infinitely surpassed by its repulsive "force."

The preceding paragraph exhibits a glaring contradiction of inferences; for the conclusions are as contrary as they can be; and my

opponent considers as useless the mechanical maxim upon which mine is founded. This perplexity must be removed if possible; and the following observation perhaps will place it in a clearer light, than that in which my friend has left it. The grounds of my inferences have been already stated at large; and should any of the arguments prove false, they are exposed to criticism. On the contrary, Mr. Dalton's reasons have not been published; consequently any mistake they may happen to contain, will be guarded from detection by our ignorance of his principles, unless his conclusions can be refuted, by comparing them with facts and the axioms of Natural Philosophy.—This comparison has been made on my part in various instances, to shew the incompatibility of Mr. Dalton's system with sound principles, and the operations of nature. But this gentleman endeavours to invalidate certain inferences of mine, which press too heavily upon his hypothesis, in a manner that may be called rash; because it contradicts an essential proposition in Mechanics. He refuses to introduce into the dispute, the centres of gravity of the fluids which are to be mixed, on a presumption that the consideration is useless: and this bold innovation in the mechanical philosophy is sanctioned by nothing but a solitary observation,

which implies, that the force of gravity upon a particle of an elastic fluid is infinitely surpassed by the repulsive force of that particle. The truth of this remark, considered as a maxim in pneumatics, is fully admitted on my part; but as no logical deductions are derived from it by my friend, I am obliged in the present instance to pursue the same conduct which I have observed on a former occasion in this dispute, and to attack the application of his principles; because it is in vain to look for a scrutiny of arguments, where no arguments exist. The business then of the next paragraph is to shew, that Mr. Dalton's maxim in pneumatics does not forbid a philosopher, who is going to assign the phenomena of a gaseous mixture, to take into consideration the centres of gravity of the fluids, which are to be mixed.

Mathematicians have proved the centre of gravity to constitute an important point in every body, being the place of its motion as well as inertia: and had not my friend's zeal for his hypothesis got the better of his geometry, he must have recollected, that the theorem, which determines the existence and true situation of this centre, is derived from the relative positions and respective quantities of matter contained in the particles, composing a body or system of bodies; which quantities of matter

are in the same ratio with the weights of these particles. The theorem then arises from the consideration of weight, unconnected with that relation, which the power of gravity, acting upon the constituent particles, has to any internal force, which actuates the elementary parts of a body. On the other hand, the centre of gravity being the place of motion and inertia, it is the true centre of their effects, namely, action and reaction; finally, it is the true seat of the mechanical energies of all bodies, whether they be fixed, liquid or aëriform. These are the reasons which induced me a while ago to pronounce Mr. Dalton's manner of proceeding rash; because he will now perceive, that his pneumatical maxim has no power to injure those inferences, which it was intended to destroy. My demonstration rests on this principle: the aggregates of two sets of heterogeneous particles, which are mutually inelastic, form two elastic fluids; the mechanical energies of which reside in their respective centres of gravity. The arguments constituting the demonstration are given in my former paper; and I am ready to refer this part of the controversy to the arbitration of the mathematical world, should the Society honour that paper with a place in their memoirs.

The preceding remarks on Mr. Dalton's

letter appear to contain all that is necessary to vindicate the mathematical part of my theory; consequently it is time to dismiss the subject, and to take a review of such of his objections as are intended to weaken the force of the conclusions, which I have deduced from reputed facts, and my own experience. To begin then with his objections to the arguments, which Mr. Schmidt's experiments supply me with, it will be adviseable to give them in the words of Mr. Dalton's letter.—

"Another argument against me is derived "from Schmidt's experiments on the expansion "of dry and moist air: from which you justly "infer, (with the exception of a small error in "taking Schmidt's number for moist air for 60° "instead of 59°) that if my theory be right he "must have made his experiments on air of "15 or 16 inches pressure, and some of them "on air from 8 to 5 inches pressure. Now I "have no hesitation in resting the merits of the "theory upon this inference; if a theory will "in all cases tell how a man has made his ex-"periments, I take it to be a tolerably good "one. The volume of Gren's Journal, con-"taining Schmidt's apparatus, is not in Man-"chester; but I hope soon to learn the fact. "In the mean time I have the authority of "Col. Roi, de Saussure, and your own to cor-

" roborate mine, that his numbers are much " too large for air of 30 inches pressure. If " you will examine the differences of his " numbers above and below 90°, you will " find something wonderful in the quick tran- " sition from 12,12, &c. to 115, 116, &c.; this " being the temperature at which, I calculate " he has changed his air from 15 to 7 or 8 " inches pressure."

The objections contained in the foregoing quotation, are of a critical nature; and a proper reply to them requires a mode of expression, to which I recur with reluctance: but in controversy, the plain language of inquiry will always supersede the punctilious style of good breeding. I allow then a theory to be a good one, which will tell in all cases how a man makes his experiments; at the same time it is equally certain, that if a theory invariably mislead the judgment in this particular, its information is no proof of its correctness. In order to rescue his hypothesis from the latter imputation, my friend informs us he has found by calculation, that Mr. Schmidt, in his experiments upon air saturated with moisture, changed the pressure of his apparatus, at 90 degrees of temperature, from 15 to 7 or 8 inches of Mercury. Now is not this begging the question? The procedure undoubtedly

favours the theorem, which is implicated in the same charge with the hypothesis, by constituting it the sole judge of the evidence brought against them. The surmise also accuses a stranger, apparently in an unguarded manner, of being unacquainted with the simplest doctrine of Hydrostatics and Pneumatics; though this stranger has had the honour of being introduced to the philosophers of England, by Mr. Kirwan; who moreover pays him the compliment of giving a decided preference to his experiments upon the elastic force of vapour.

A table will be inserted in the postscript, to prove, that Mr. Schmidt has changed the pressure of his apparatus frequently, if he changed it at all. The truth is, there is every reason to suppose, he used the mean weight of the atmosphere; but as Mr. Dalton has called the circumstance in question, this part of the dispute may be properly left to the parties concerned in it; and the event cannot prove of any moment to me, because the following extract from my friend's letter will shew the impression that has been made on his sentiments, by the experiment with the moist bottle; at the same time, he does not appear to be fully sensible of the change, which they have undergone.—" With regard to your own

" experiment, as the result of it agrees with
" all the above authorities,* Schmidt's only
" excepted, I cannot question it. The vapour
" in your experiment was of the force of 3.1
" inches; the force of vapour of 126° in my
" table is 3.89 inches; but the reason why
" your's falls short of mine is, two minutes are
" insufficient to diffuse the full quantity of
" vapour through a bottle of such magnitude;
" the temperature within would not be quite
" 126°; and the uncovering it with the hand
" suffers a small portion of the internal vapour
" to escape, which cannot be restored in an
" instant. But how is this result to be recon-
" ciled with Schmidt's, which makes the force
" of vapour of only 106° nearly 10 inches?
" If you have any doubt remaining of the in-
" decisive nature of Schmidt's experiments on
" moist air, you have nothing to do but to
" immerse the same phial perpendicularly,
" with its mouth open downwards in water of
" 106°, and keep it in that position till no
" more bubbles escape, which I presume will
" be in 4 or 5 minutes.—Then treating it as
" before, and allowing for the additional
" pressure of the water, the full quantity of
" vapour may be obtained. If you find it to

* Col. Roi, and M. de Saussure.

" be *one-fourth part* of Schmidt's number, I " shall give up the theory as indefensible; till " then I may be allowed to wave all arguments " drawn from his experience.——Your in- " ference from your experiment I disallow. " I am sorry, that you and some others have " misunderstood my language; though it ap- " pears to me to be your fault rather than " mine. The expression alluded to is this: ' The particles of A meeting with no repul- ' sion from those of B, further than that re- ' pulsion which as obstacles in the way they ' may exert, would instantly recede from ' each other as far as possible in their circum- ' stances, and consequently arrange them- ' selves just as in a void space.'* You seem ' to understand it thus, ' The particles of A, ' meeting with no repulsion from those of B, ' would instantly recede from each other as ' far as possible in their circumstances, and ' *instantly* arrange themselves just as in a void ' space.' Whereas my meaning was, ' The ' particles of A, meeting with no repulsion ' from those of B further than that repulsion ' which as obstacles in the way they may ' exert, the amount of which can only be as- ' certained by experiment, would *instantly* ' recede from each other as far as possible in

* Manchester Memoirs, Volume 5, p. 554.

'their circumstances, and *in the sequel* ar-
'range themselves just as in a void space.'
" The truth of the inference thus understood is
" so obvious from the fundamental principles
" of the theory, that I do not know what can
" be said to illustrate it to any one, who un-
" derstands the object of my 4th proposition.

" To return now to your experiment. Vapour
" certainly does enlarge the pores of air, and
" that because it cannot *instantly* escape
" through them, but must push against the
" particles of air themselves; but why the ne-
" cessity of having the force of 30 inches to
" effect this enlargement of the pores? If
" two particles of a gas have a given distance
" of 99, it does not require a force equal to
" their mutual repulsion, to remove them to
" the distance 100, but only $\frac{1}{100}$ of that force;
" why then may not the moderate force of
" vapour enlarge the pores of air in experi-
" ments made at low temperatures; though it
" is unable to drive the air wholly out?"

The first sentence of the preceding quotation confirms the accuracy of the experiment with the moist bottle, as far as is necessary: for the design of it was to demonstrate, that the presence of water increases the expansion of air of a given temperature; and the circumstance has been admitted by the advocate for

the separate existence of vapour, in a manner which bespeaks a laudable disregard of consequences. My end then has been answered, by means which were not intended at the time to discover the full extent of the expansive power of the moist air in the bottle; and it would be impolitic on my part, to engage at present in the practical part of a dispute which lies wholly betwixt Mr. Dalton and Mr. Schmidt. The former gentleman has recourse to the experiment in question, with a view to depreciate the credit of the latter, by its assistance; but in all probability the bad effects of the undertaking will ultimately fall upon his own theory. Schmidt does not state the elastic force of vapour of 106° at 10 inches or nearly so; on the contrary, the force of vapour of 106,25° amounts according to his table to no more than 2,23 inches, French measure.* This exaggerated statement appears then to result from his method of calculating, and cannot be said to place his principles in a very favourable light. In reality, this is as a second endeavour to withdraw the suspected theorem from the station of defendant, in order to promote it to a tribunal, where it is to judge its own case.—My friend, perhaps, will recollect,

* The French linear inch is to the English, as 1, to 0.938.

that he has other arguments to answer, besides those that are furnished by Schmidt; and that whilst these objections to his doctrine remain in force, they oblige him to consider moist air in the light of a chymical compound. Now any attempt to calculate the force of vapour in a mixture of this description is visionary, and must prove a source of error, if put in practice; because it is impossible to discover the qualities of a chymical compound from the known properties of its ingredients. Mr. Dalton's confidence in his theorem is evidently connected with a notion, that vapour, mixing with perfectly dry air increases the spring of it, to the exact amount of its own force.* But there are strong reasons to suspect his manometers of being very treacherous guides: a tube of $\frac{1}{15}$ of an inch internal diameter is too narrow: the mercury cannot play freely in it; and the experimenter is at liberty to estimate at pleasure the errors, arising from its impeded motion. The supposed power of vapour to increase in appearance the elastic force of air confined in a manometer, is mentioned and explained in such expressive words by Mr. Dalton, that nobody can mistake his meaning. Indeed his style is in general too correct and perspicuous

* Manchester Memoirs, Vol. 5, p. 537.

to create any doubt or misconception; in the present instance, however, he accuses several of his readers of misunderstanding his fourth proposition; and the nature of the mistake is clearly stated in the foregoing quotation. My essay will shew, that the charge does not reach me; because the impossibility of two gases mixing instantaneously is demonstrated, immediately preceding the refutation of that proposition.

Thus much may be said in relation to the notion of gaseous fluids penetrating each other. As for the application of the general idea to the particular case of vapour, Mr. Dalton's readers have an indisputable right to vindicate their understandings, by quoting such passages of his essays as they may think proper: the passage alluded to in particular by me, is this. "The "obstruction, however, cannot arise from "the weight of the atmosphere, as has till now "been supposed; for then it would effectually "prevent any vapour from arising under 212°; "but it is caused by the *vis inertiæ* of the par- "ticles of air; and is similar to that which a "stream of water meets with in descending "amongst pebbles."*

The preceding illustration of the passage of

* Manchester Memoirs, Vol. 5. p. 530.

vapour through a bed of air always appeared to me repugnant to the mechanical philosophy; and my objections to the hypothesis shall be stated in their proper place. In the mean time, the context of the quotation, more especially the happy and familiar elucidation of water descending through pebbles, shews Mr. Dalton to have once imagined, that the particles of air oppose an insuperable resistance to the impulse of vapour of low temperatures. But the conviction of experiment has vanquished this favourite opinion; and the author of it seems desirous of concealing an important change of sentiment, by charging his readers with a want of penetration. My friend acknowledges, that vapour of less than 212° does enlarge the pores of air; this is his present notion; and by way of defence he asks, why a force, inferior to the weight of the atmosphere, cannot increase the distance of two gaseous particles in a small degree? My reasons for rejecting the substance of this question will appear in the next paragraph; and perhaps they may be considered to furnish a refutation of M. De Luc's hypothesis, with all the corrections that can be given to it.

A maxim in Pneumatics has been already quoted from Mr. Dalton's letter; which would in all probability have been delivered nearly

in the following words, had not the hurry of writing induced him to express his thoughts in a manner, which appears to be somewhat too general. "The force of gravity upon a par- "ticle of the atmosphere is infinitely surpassed "by the repulsive force, which the same par- "ticle exerts on the nearest corpuscles of its "own kind." The preceding maxim cannot be called a self-evident truth; because it is derived in the following way, partly from experiment, and partly from argument. The air has been found by experimental philosophers to have weight and elasticity; which properties are supposed to reside in the constituent particles of the mass. Hence it happens, that each particle endeavours to descend perpendicularly; but is prevented from falling below a certain point, by the repulsive force of the next inferior particle lying in the same vertical line: thus the latter particle sustains the former with all the pressure, which urges it downwards at the time; that is, it supports the whole weight of the incumbent column, consisting of gaseous particles of its own kind. Now as the number of incumbent particles is indefinitely great in the nether parts of the atmosphere, the weight of any one corpuscle cannot have an assignable ratio to the united pressure of the whole; which is equal to the

repulsive force of the particle that sustains the superior column.

The truth of the maxim being thus established upon the axioms of Mechanics, it must be used in the next place to discover the least adventitious force, which can enlarge the pores of a gas, by increasing the distance of the contiguous particles.

It is evident, that during the mutual separation of the corpuscles, each superior particle must recede more or less from the particle, which lies immediately under it; that is, it must ascend in opposition to its natural propensity to descend. Now the power, which urges a corpuscle upwards, exceeds its original bias downwards; because when a body is actuated by two contrary forces, it always moves in the direction of the stronger. Consequently the least adventitious force, that can enlarge the pores of a gas, must somewhat surpass the pressure, which urges the particles of it downwards: but this pressure on any particular particle consists of the collective weights of all the incumbent particles. Hence it appears, that vapour, which enters a gas, has something to contend with besides the *vis inertiæ* of a number of minute atoms: it must overcome the force of gravity upon the whole fluid; that is, it must acquire a boiling heat,

before it can effect an entrance, according to Mr. Dalton's own experiments.

The preceding arguments are derived from self-evident principles; and they discover the reason, why Mr. Pictet and others have proved unable to do away the objections to which the weight of the air exposed their favourite notion. In reality the objections appear to be unanswerable; because the notion has been demonstrated to be repugnant to the mechanical philosophy. Mr. Dalton lately invented an ingenious correction of M. de Luc's hypothesis, according to which, vapour, in passing through a stratum of air, meets with a resistance from the inertia of the gaseous particles, similar to the opposition a current experiences in making its way through a bed of pebbles. The inference that follows this familiar illustration is obvious; namely, that the particles of air remain immoveable like the pebbles, the one doing nothing, but obstruct the progress of the steam, just as the other diminishes the velocity of the water. But though the merit of my friend's corrected hypothesis depends upon the establishment of this new idea, he seems desirous to abandon it at present, and maintains that vapour of low temperatures does enlarge the pores of air; he must therefore be contented to rank with M. Pictet,

and the other unsuccessful advocates for an aqueous atmosphere, until he has refuted the preceding arguments, which have been deduced from his own maxim in pneumatics.

A table shewing the various degrees of pressure, under which Mr. Schmidt made his experiments on air saturated with moisture according to Mr. Dalton's theorem.——N. B. The temperature in this table is expressed by the scale of Reaumur, and the pressure by the height of a column of mercury in French inches, the force of vapour being taken not from Mr. Dalton's, but Schmidt's table published in Nicholson's Journal for July, 1803.

Temp.	Press. in inch.
1°	1.65
5°	18.10
8°	16.33
10°	14.86
12°	16.44
15°	16.48
20°	16.30
25°	15.7
28°	8.7
30°	6.5
32°	2.9
33°	5.2

JOHN GOUGH.

Middleshaw, Dec. 2d, 1803.

P. S. Since writing the preceding letter I have made an experiment, which leads me to agree with Mr. Dalton, in suspecting Schmidt's accuracy. I desire, however, to keep my judgment in suspense, until his experiments have been repeated by some philosopher, whose impartiality cannot be called in question. In the mean time, the arguments which have been drawn from his table, must lie under the same suspicion as the table itself: but this circumstance is of no moment; because it only invalidates a collateral proof, without affecting the principal facts and conclusions.

J. G.

REMARKS

ON

Mr. GOUGH'S *two Essays on the Doctrine of Mixed Gases; and on Professor* SCHMIDT'S *Experiments on the Expansion of Dry and Moist Air by heat.*

BY JOHN DALTON.

Read October 4, 1805.

TWO Essays on the Theory of Mixed Gases and on the state of water in the Atmosphere, have been read to this Society, the former in 1803, and the latter in 1804, having an especial relation to my Essays on the same subjects which were published in the Memoirs of this Society, Vol. 5. part 2.—Having formerly had some conversation with the author of those essays on the subject, in which I found his sentiments did not accord with mine, I desired him to commit them to paper, apprehending that if any substantial argument against my peculiar doctrine existed, he would lay hold of it, and exhibit it in a clear point of view.—Some time after this, the former of the two essays (page 296) was presented to the Society

and read. In returning the thanks of the Society to the author, I gave him, agreeably to former intimation, my opinion on his arguments, couched in terms of respect, as may be seen in his second essay, into which the greater part of my letter was transcribed. It was intended by me for a letter of friendship, and not a formal discussion for public inspection.—In a few months after came his second essay (page 405); this, as may well be imagined, by any one who peruses it, was not entitled to the same notice from me as the former; because in discussions relative to experimental philosophy, we expect facts opposed to facts, and arguments to arguments; whereas in the present instance Mr. Gough has done little more than insinuate that my instruments are inaccurate, and the results of my experiments unfaithfully represented, without in any one instance bringing either of these charges home to me.

It is not my design to spend much time in animadversion on these two papers: such parts of my letter as are quoted in the second of them contains all the observations of importance on the first: but as some of those observations involve facts and circumstances not then ascertained, it will be necessary to relate what has since transpired.

It may be recollected that Mr. Gough refers us more than once for authority to the experiments of Professor Schmidt of Giessen, which have been largely quoted by Kirwan, in his Essay on the Variations of the Atmosphere, in the 8th vol. of the Irish Transactions. (See also Nicholson's Journal, vol. 5, page 207). This Gentleman made a series of experiments on the force of pure steam, and on the expansion of dry and moist air, which were published in Gren's Physical Journal, 1798: Mr. Kirwan's Essay was read in 1801, and in the succeeding year my essays on the same subjects as Schmidt's were published, without any acquaintance with his results.—Mr. Kirwan, finding Schmidt to be a careful experimenter and well acquainted with the labours of his predecessors, naturally gave him the preference to them; but not informing us of the structure of his apparatus, we could gain no knowledge on that head but from the original, a work scarce in this country. As the results of his experiments on moist air, *as exhibited by Kirwan*, differed remarkably from mine, I was anxious to know the nature of his apparatus: I wrote to him by a friend requesting the favour of a plate or other description of it; in the mean time, guided by the theory of moist air which I had confidence was fully

established, I ventured to assent to Mr. Gough's calculation at page 312, as mentioned in my letter, page 410; namely, that Schmidt must have made his experiments with the pressure of 15 or 16 inches of mercury.

That Gentleman, in due course, answered my note by a polite letter, accompanying a copy of his essays in the German language.* On looking it over I was surprised to find not a single trace of the table given by Kirwan as his, exhibiting the expansion of moist air; what increased my surprise was to find *another* table on the expansion of moist air at page 353, totally different from the one alluded to, and calculated for every 10° of the hygrometer and for every 5° of the thermometer (Reaumur's) from Schmidt's own experiments; that column of it which is for saturated air, or when the hygrometer is at 100°, I shall extract, as being the only one to my purpose, and the one which Kirwan evidently intended to give; along with which I shall place a corresponding table of expansion calculated from my own experience, or rather from the theory to which it led me. I adopt Schmidt's numbers for the expansion of

* Versuche uber die expansivkraft dichte und latente hitze des reinen wasserdampfes bey verschiedenen temperaturen, und uber die ausdehnung der trocknen und feuchten Luft durch die warme.

dry air, as not differing materially, as far as respects the present subject, from my own; I take the force of vapour from my table (Memoirs vol. 5, part 2. page 559) from which that of Schmidt no where differs widely. I calculate from 1 part of air saturated with moisture at the temperature of 32° in order to compare with Schmidt, and for every 5° of Reaumur's scale. The boiling point is supposed in mine to be taken at 30 inches of the barometer, though his is taken at 28 French inch. which is somewhat lower. The theorem from which I calculate is given at page 572 of the Memoirs above quoted; namely, $\frac{30 \times \text{dry air}}{30 - f} =$ space occupied by air in contact with heated water, for any temperature; where f = force of vapour of the given temperature in inches of mercury: the dry air in 1 measure saturated at 32° is equal ,9933.—I have rejected Decimals in both tables, beyond the fourth place.

Table of the Expansion of a given quantity of dry air heated in contact with water.

TEMPERATURE. Fahrenheit.	Reaumur.	SCHMIDT's. 1 Measure of air saturated with moisture = ,9933 dry.	DALTON's. 1 Measure of air saturated with moist. = ,9933 dry.	KIRWAN's from Schmidt by mistake.
32°	0°	1.0000	1.0000	1.0000
43½	5	1.0246	1.0257	1.0236
54½	10	1.0528	1.0531	1.0647
65½	15	1.0804	1.0858	1.1045
77	20	1.1120	1.1156	1.1528
88½	25	1.1473	1.1538	1.2114
99½	30	1.1867	1.1997	1.6100
110½	35	1.2316	1.251	1.98 for
122	40	1.2838	1.326	33°
133½	45	1.3446	1.418	
144½	50	1.4166	1.548	
155½	55	1.5023	1.73	
167	60	1.6198	2.01	
178½	65	1.7872	2.50	
189½	70	1.9438	3.49	
200½	75	2.1351	6.03	
212	80	2.3574	Infinite.	

From the above tables, it appears that my numbers are incomparably nearer to Schmidt's than those given by Mr. Kirwan, which are represented as Schmidt's.—Unfortunately Mr. Gough has built a good deal on this table, has given us another at page 423 founded on it, has given it a decided preference to mine; but immediately after he tells us that all he has obtained from it is suspected of inaccuracy.

Mr. Kirwan, like other men, is fallible; he has certainly committed an oversight in

drawing up the table in question, which it would be easy in me to point out; but I do not desire so invidious a task; more especially respecting one who has so well deserved of the philosophical world; only I would take this opportunity to caution others from taking too much upon credit, when they may easily satisfy themselves from their own experience.

Schmidt's apparatus, and mode of experiment, which was my particular inquiry, come next to be noticed.—The apparatus was on a simple principle; being nothing more than a common barometer tube, having a bulb turned up at the lower end, to which a glass vessel or two could be adapted containing water or steam, and having proper stop-cocks, &c. by means of which steam could be driven into the bulb and made to expel the whole or any part of the contained air; when this was done the whole was made air-tight and immersed into water of 32°; the condensation of the steam left the air inclosed to support such a column of mercury as it was able, which was noticed; the whole apparatus was then immersed in water of any other temperature, and the rise of the mercury indicated the expansion arising from both air and vapour. The result of his 3d experiment on this head follows, which is the one he most relies on. See page 343.

TEMPERATURE.	EXPANSION OF AIR OVER WATER.
Reaumur.	Inches (French).
0°	15.88
15	17.30
20	17.89
25	18.58
30	19.52
35	20.33
40	21.47
45	22.40
50	24.58
53	26.70
60	29.62
65	34.00

Above the temperature of 65°. Mr. Schmidt seems to think the force of steam in air the same as the force of pure steam of the same temperature; which is the principle I maintain for the whole scale; but below that temperature he infers from teh above table, compared with that shewing the expansion of pure steam, that steam mixed or combined (whichever it be) with air, has less force than when pure.—This deviation arises from his operating with a variable pressure; if he had done in the manner I have, namely, have kept a uniform atmospheric pressure at all temperatures, and marked the expansion accordingly, he would have found, as I did, that the expansive force of vapour in any part of the scale of temperature is precisely the same when mixed with

any kind of air as when pure: Indeed by his own method, it is evidently so at that point where the pressure was equal to 28 or 30 inches; that is, about the temperature 60 or 65°.

Mr. Gough will hence be enabled to learn how far he and I have been misled by my theory when we both calculated that Schmidt made his experiments on air of 15 or 16 inches of pressure.

Upon looking over the numbers Mr. Schmidt has given for the expansion of moist air, it is evident he has gone upon the supposition that the space occupied by any volume of moist air (or rather air confined by water) is inversely as the pressure. Thus, the space occupied by 1 measure of dry air at a given pressure and temperature of 32°, being 1.3574, at 212°, he infers that by admitting water to it the space would become 2.3574; that is, according to him, if 1,000 part of air at 32° and 28 inches pressure be heated to 212°, it will require a pressure of 38.0072 inches to retain it in the same space by reason of its increased elasticity; and if to this, water be admitted, it will then require the addition of 28 inches more, or 66.0072, to retain it in the same space (see page 351). Now this last is strictly true in fact; but the former by no means follows as a consequence;

because, a mixture of air and vapour in the above circumstances is different in regard to the law of elasticity from dry air; namely, the space is not inversely as the pressure. Mr. Gough can make no difficulty of deciding this point with his bottle; for if he hold it with the mouth downward in boiling water for a few minutes, on cooling the water it will ascend so as to fill the whole bottle nearly, and there will not remain $\frac{5}{77}$ of the original air according to Schmidt's table.

From what has been said, it will appear that I consider Schmidt's table of the expansion of moist air as essentially wrong; I would not, however, be understood to depreciate the rest of his work, which appears, from what I have seen of it, to be very ingenious and valuable.

I shall now conclude with a few observations on Mr. Gough's two Essays.—All the abstruse investigation of the centre of gravity, &c. at page 299 and *seq.* is altogether superfluous; because every one must admit as a self-evident truth, the deduction from it at page 301. The observation commencing page 302 is a complete contradiction in terms; to allow the *particles* of two elastic fluids to be *inelastic* towards each other, at the same time that given *volumes* of such fluids are not so; seems to be the same thing as allowing that the *whole*

any kind of air as when pure: Indeed by his own method, it is evidently so at that point where the pressure was equal to 28 or 30 inches; that is, about the temperature 60 or 65°.

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this pressure had any influence whatever in modifying the action of both proximate particles, *a*, on the middle one, except so far as that it might increase or diminish their distance; the mutual action of homogeneous particles I always considered as resembling magnetic action, which is not affected by whatever other action takes place, or whatever other body intervenes.—I should certainly have enlarged on this head previously, if I had at all imagined Mr. Gough was under any misapprehension, or had not read the illustration I gave in Nicholson's Journal, vol. 3, page 267, *new series*, which was written about a year after the original annunciation of the theory in his 4to Journal for 1801.

(Correction of an Error in Table at page 272.)

Since the Table at page 272 was printed off, I have discovered that the quantity of carbonic oxide gas absorbed by water is about $\frac{1}{36}$th of its bulk, not $\frac{1}{54}$th, as there stated: it is the only gas I have yet found that is anomalous in this respect.

LIST OF BOOKS, &c.

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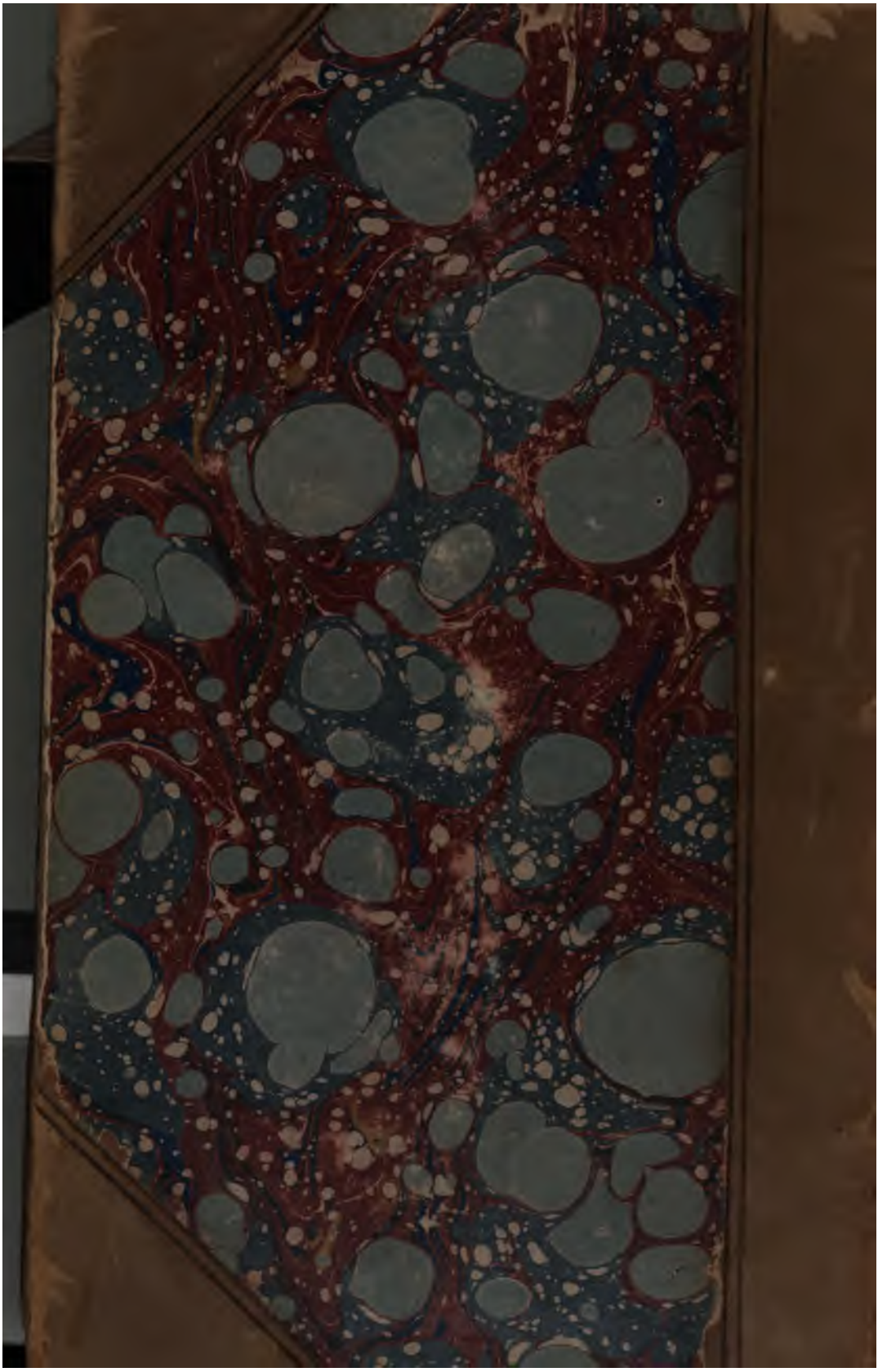
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